

Effectiveness of an influenza vaccine programme for care home staff to prevent death, morbidity, and health service use among residents: cluster randomised controlled trial

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Abstract

Objective To determine whether vaccination of care home staff against influenza indirectly protects residents.

Design Pair matched cluster randomised controlled trial.

Setting Large private chain of UK care homes during the winters of 2003-4 and 2004-5.

Participants Nursing home staff (n = 1703) and residents (n = 2604) in 44 care homes (22 intervention homes and 22 matched control homes).

Interventions Vaccination offered to staff in intervention homes but not in control homes.

Main outcome measures The primary outcome was all cause mortality of residents. Secondary outcomes were influenza-like illness and health service use in residents.

Results In 2003-4 vaccine coverage in full time staff was 48.2% (407/884) in intervention homes and 5.9% (51/859) in control homes. In 2004-5 uptake rates were 43.2% (365/844) and 3.5% (28/800). National influenza rates were substantially below average in 2004-5. In the 2003-4 period of influenza activity significant decreases were found in mortality of residents in intervention homes compared with control homes (rate difference -5.0 per 100 residents, 95% confidence interval -7.0 to -2.0) and in influenza-like illness (P = 0.004), consultations with general practitioners for influenza-like illness (P = 0.008), and admissions to hospital with influenza-like illness (P = 0.009). No significant differences were found in 2004-5 or during periods of no influenza activity in 2003-4.

Conclusions Vaccinating care home staff against influenza can prevent deaths, health service use, and influenza-like illness in residents during periods of moderate influenza activity.

Trial registration National Research Register N0530147256.

Introduction

Vaccination of care home residents against influenza can be effective in preventing respiratory illness, admissions to hospital, and death.¹⁻³ The immune

response to influenza vaccine in elderly patients is, however, reduced, so that protection is only 50-70%.^{4,5} Residents are therefore vulnerable to influenza outbreaks even when vaccination coverage is high.⁶⁻⁹

Evidence shows that vaccination of healthcare workers can reduce serologically confirmed influenza by nearly 90% in those vaccinated.¹⁰ An indirect effect may also exist whereby immune staff do not infect patients.^{11,12} We studied the effect of vaccinating care home staff against influenza on mortality, health service use, and influenza-like illness among residents. We used cluster randomisation to look for indirect effects of vaccination.¹³ We compared the effectiveness of the intervention during periods with differing levels of influenza activity in the community.

Methods

We carried out a pair matched cluster randomised controlled trial of delivery of influenza vaccine to staff in a private chain of UK care homes over the winters of 2003-4 and 2004-5, with collection of data among residents. The company's policy was not to offer staff influenza vaccination, but to routinely offer influenza vaccine to residents through local general practitioners.

The company agreed to adopt a policy for influenza vaccination of staff in randomly selected intervention homes while maintaining their policy of not actively promoting vaccination in control homes. Lead nurses in the intervention homes acted as advocates for vaccination. Staff in intervention homes were eligible for vaccination. A local occupational health service provided three vaccination sessions (at least one during a night shift) within the homes in October. Staff in control homes were informed of the study by letter and advised of the Department of Health recommendation that adults with chronic illness should be vaccinated by their general practitioner.

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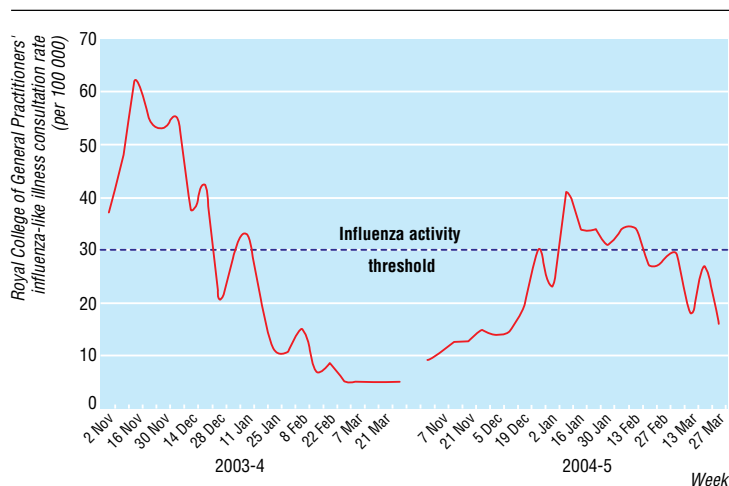
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Forest plots for rate differences during year 1 are on bmj.com



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Royal College of General Practitioners' consultation rate for influenza-like illness (consultations per 100 000 population) and periods of influenza activity

We hypothesised that the vaccine promotion programme for staff would reduce transmission of influenza to residents and therefore reduce influenza-like illness and associated deaths and health service use in residents during and immediately after periods of influenza virus activity.

Outcomes in residents were collected as aggregate data within each home. The primary outcome was all cause mortality. Secondary outcomes were influenza-like illness, mortality with influenza-like illness, admissions to hospital from any cause, admissions to hospital with influenza-like illness, and consultations with a general practitioner for influenza-like illness. The lead nurses collected daily data on numbers of residents with primary or secondary outcomes. Influenza-like illness was defined as a fever of 37.8°C or more, or an acute deterioration in physical or mental ability, plus either new onset of one or more respiratory symptoms or an acute worsening of a chronic condition involving respiratory symptoms. Data were returned weekly. Only aggregate non-identifiable data were collected.

We placed homes into matched pairs on the basis of size, proportion of residents requiring high dependency care, and mortality of residents. We then selected the 25 most closely matching pairs. A researcher blinded to the home's identity and characteristics carried out randomisation within these pairs.

Statistical analysis

We used national data from the Royal College of General Practitioners' sentinel surveillance scheme to divide the study into periods of influenza activity.¹⁴ The start of the period of influenza activity was defined as the beginning of the week in which the weekly consultation rate rose above 30 per 100 000. The end was defined as one week after the weekly consultation rate returned and remained below this baseline level for influenza-like illness and for general practitioner consultations for influenza-like illness, and two weeks after the consultation rate fell below baseline for admissions to hospital and deaths (figure).

We analysed outcomes at a cluster level using aggregate data for each cluster. To take account of the matched clustered design we used a random effects

meta-analysis.¹⁵ This treated the results from each pair of homes as a separate study and provided a pooled estimate of effect weighted for the size of homes and the size of the effects and their standard errors. We calculated the outcome rates per resident period for each home during periods of influenza activity and no activity. The rates were measures based on person time where the denominator was the average number of residents during the period of interest and the numerator was the number of events in these residents during the period. For each pair of homes we calculated the rate difference (intervention minus control); a negative value indicating that the intervention prevented events. We used RevMan software to produce weighted estimates of the overall rate difference, 95% confidence intervals, and levels of statistical significance. To test for interaction between year and intervention we used a multilevel Poisson model. When significant protection of residents was observed we calculated the number of staff vaccinations needed to prevent one event in residents (number needed to treat).

Results

Influenza activity was below average in 2003-4 but nearly double that in 2004-5 (figure).¹⁴ Laboratory surveillance confirmed that influenza A H3N2 was circulating during these periods.

Analyses relate to 22 pairs of care homes (no outcome data were available for the three pairs of homes excluded so an intention to treat analysis was not possible; see bmj.com). Intervention and control homes had similar baseline characteristics (see bmj.com).

Influenza vaccine coverage among full time staff in intervention homes was 48.2% in 2003-4 and 43.2% in 2004-5 compared with 5.9% and 3.5% in control homes (a small number were vaccinated by their general practitioner or occupational health service). Uptake was lower in part time staff (intervention homes, 21.2% and 18.4%; control homes, 4.0% and 4.0%). In both years the influenza A H3N2 subtype included in the vaccine differed from the circulating subtype, but antigenic similarities were sufficient for the vaccine to be protective.

The table shows the number of outcome events during periods of influenza activity and no activity in intervention and control homes, the average number of residents in each, and event rates per resident period for each period.

Intervention homes had significantly lower all cause mortality during the influenza period of 2003-4 (rate difference per 100 residents per period -5.0, 95% confidence interval -7.0 to -2.0) compared with control homes (number needed to treat 8.2, 5.8 to 20.4). The effect was not seen during periods of no influenza activity or in the 2004-5 period when influenza levels were low. In the influenza period of 2003-4 significantly lower rates were found for the secondary outcomes in intervention homes: influenza-like illness (rate difference per 100 residents per period -9.0, 95% confidence interval -14.0 to -3.0; number needed to treat 4.5, 2.9 to 13.6), general practitioner consultations for influenza-like illness (-7.0, -12.0 to -2.0; number needed to treat 5.8, 3.4 to 20.4), and

admissions to hospital with influenza-like illness (-2.0 , -3.0 to 0 ; number needed to treat 20.4 , 13.6 to 102.1). Evidence was found of significant heterogeneity of results for influenza-like illness and associated general practitioner consultations (see bmj.com). No significant differences were found in secondary outcome measures during any other period.

Discussion

Vaccinating care home staff against influenza can prevent deaths in residents, morbidity, and health service use during moderate influenza activity. The reduction is equivalent to preventing five deaths, two admissions to hospital with influenza-like illness, seven general practitioner consultations for influenza-like illness, and nine cases of influenza-like illness per 100 residents during influenza activity. The numbers of staff vaccinations needed to prevent one each of death, influenza-like illness, general practitioner consultation for influenza-like illness, and admission to hospital with influenza-like illness were 8, 5, 6, and 20. These effects were seen despite high levels of vaccination of residents (poor immune response to vaccine in elderly people can leave them vulnerable to influenza). In

addition to the reductions in mortality and morbidity, the intervention has the potential to reduce health service costs during moderate influenza activity, and especially during epidemics.

Lead nurses were not blinded to the intervention. Introducing a placebo arm would have diminished participation rates and would not have been compatible with running a vaccine promotion campaign. We chose all cause mortality as the primary outcome because it is not subject to observer bias. Nurses in intervention homes might have been less likely to label residents' illnesses as influenza if they believed that the intervention protected residents. This would have led to lower rates of influenza-like illness in intervention homes throughout the study, not just during influenza activity. Conversely nurses in intervention homes might have been more likely to detect influenza, owing to raised awareness.

The intervention was randomly assigned and baseline characteristics of residents in intervention and control homes showed no significant differences that could have accounted for the observed effect. The 4% higher uptake of vaccination in residents in intervention homes could not have accounted for the 25% decrease in mortality or a halving of the influenza-like

Numbers of outcome events and event rates in intervention and control homes

	Intervention homes		Control homes		Weighted rate difference (95% CI)	P value
	No of events	Events per resident	No of events	Events per resident		
Year 1						
Period of influenza activity:						
No of residents	n=1249*		n=1323*		—	—
Death	140	0.112	203	0.153	-0.05 (-0.07 to -0.02)	0.002
Influenza-like illness	142	0.114	300	0.227	-0.09 (-0.14 to -0.03)	0.004
General practitioner consultations for influenza-like illness	125	0.100	247	0.187	-0.07 (-0.12 to -0.02)	0.002
Admissions to hospital	105	0.084	144	0.109	-0.02 (-0.05 to 0.02)	0.35
Admissions with influenza-like illness	4	0.003	23	0.017	-0.02 (-0.03 to 0.00)	0.009
Death with influenza-like illness	13	0.010	19	0.014	-0.01 (-0.02 to 0.01)	0.24
Period of no activity:						
No of residents	n=1176*		n=1284*		—	—
Death	97	0.082	94	0.073	0.00 (-0.03 to 0.03)	0.93
Influenza-like illness	114	0.097	114	0.089	0.00 (-0.05 to 0.05)	0.93
General practitioner consultations for influenza-like illness	87	0.074	99	0.077	-0.01 (-0.06 to 0.041)	0.74
Admissions to hospital	77	0.065	86	0.067	0.00 (-0.04 to 0.03)	0.80
Admissions with influenza-like illness	3	0.003	8	0.006	-0.01 (-0.02 to 0.01)	0.32
Death with influenza-like illness	6	0.005	7	0.005	-0.01 (-0.04 to 0.02)	0.59
Year 2						
Period of influenza activity:						
No of residents	n=1231*		n=1348*		—	—
Death	99	0.080	123	0.091	-0.01 (-0.04 to 0.02)	0.49
Influenza-like illness	149	0.121	179	0.133	0.00 (-0.06 to 0.06)	0.93
General practitioner consultations for influenza-like illness	124	0.101	155	0.115	-0.01 (-0.07 to 0.05)	0.77
Admissions to hospital	93	0.076	102	0.076	-0.00 (-0.03 to 0.04)	0.84
Admissions with influenza-like illness	12	0.010	9	0.007	0.00 (-0.02 to 0.02)	0.99
Death with influenza-like illness	4	0.003	14	0.010	-0.01 (-0.03 to 0.00)	0.08
Period of no activity:						
No of residents	n=1219*		n=1326*		—	—
Death	165	0.135	159	0.120	0.01 (-0.03 to 0.04)	0.70
Influenza-like illness	247	0.203	243	0.183	0.03 (-0.07 to 0.12)	0.57
General practitioner consultations for influenza-like illness	177	0.145	211	0.159	0.00 (-0.08 to 0.08)	0.95
Admissions to hospital	123	0.101	134	0.101	0.00 (-0.03 to 0.03)	0.86
Admissions with influenza-like illness	12	0.010	8	0.006	0.01 (0.00 to 0.02)	0.31
Death with influenza-like illness	12	0.010	6	0.005	0.01 (-0.01 to 0.02)	0.35

*Average number of residents per day in homes during period.

What is already known on this topic

Vaccinating elderly people against influenza reduces sickness and death rates but provides incomplete protection because the immunological response to vaccine is often suboptimal

Two randomised controlled trials of limited size on elderly care wards with low vaccine coverage suggest that vaccinating staff against influenza can reduce death rates during periods of high influenza activity

What this study adds

Vaccinating care home staff against influenza can prevent deaths in residents, morbidity, and associated health service use during periods of moderate influenza activity

The intervention is effective even when there are high levels of vaccination of residents and incomplete vaccine coverage in staff

illness rate. The observed heterogeneity of effect size for influenza-like illness and associated general practitioner consultations is to be expected as the effect depends on introductions of influenza that are stochastic events. Because of heterogeneity we used a random effects model to produce the summary effect estimates.

Influenza activity in 2004-5 was among the lowest recorded since 1988.¹⁴ Nearly twice as much influenza-like illness was reported in 2003-4 as in 2004-5. Because the effect size should be related to the level of circulating influenza we made an a priori decision to analyse the effect separately in the two years. This was supported by a significant interaction between year and intervention on mortality and other outcomes. The direction of effect is the same in both years but the effect is much greater in the first year when influenza activity was substantially higher. The lack of a statistically significant effect in a year with exceptionally low influenza activity is consistent with the hypothesis that the vaccination of staff prevents influenza related morbidity and mortality in residents. The fact that an effect was shown in a year with below average influenza activity suggests that a protective effect would be observed most years. Theoretically the benefits would be substantially greater in epidemic years. The effect might also have been greater if the circulating influenza strain had matched the vaccine strain more closely. Achieving higher vaccine uptake could also have increased effectiveness but is notoriously difficult in healthcare workers. Our uptake in full time staff was 48.2% (2003-4) and 43.2% (2004-5).

A recent systematic review¹⁶ of influenza vaccination of healthcare workers to reduce influenza related outcomes in high risk patients identified only two relevant studies; the first a pilot for the second.^{11 12} The main study showed a reduction in mortality from 22.4% to 13.6% over six months, with unusually high influenza activity (influenza-like illness rates peaked at 220 per 100 000). The average vaccine uptake in patients was 48% in intervention wards and 33% in

control wards and uptake of vaccine by staff was 51%. After controlling for differences in baseline characteristics the odds ratio for mortality was 0.61 (95% confidence interval 0.36 to 1.04). The mortality in our study over the three months in which influenza was circulating in 2003-4 was 15 per 100 residents in control homes and 11 per 100 residents in intervention homes. Our study also showed an important effect on mortality, but this was apparent despite much lower levels of influenza and higher vaccine uptake by residents.

This study provides strong evidence to support influenza vaccination of care home staff even when vaccine uptake by residents is high. Campaigns to promote influenza vaccination among healthcare workers or staff of long term care facilities should emphasise the protection of vulnerable patients as well as the benefits to the individual.

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