Cluster randomised controlled trial of an educational outreach visit to improve influenza and pneumococcal immunisation rates in primary care

A Niroshan Siriwardena, Aly Rashid, Mark R D Johnson and Michael E Dewey

SUMMARY

Background: *Improvement in the delivery of influenza and pneumococcal vaccinations to high-risk groups is an important aspect of preventive care for primary healthcare teams.*

Aim: *To investigate the effect of an educational outreach visit to primary healthcare teams on influenza and pneumococcal vaccination uptake in high-risk patients.*

Design: *Cluster randomised controlled trial.*

Setting: *Thirty general practices in the Trent region, UK.*

Methods: *Fifteen practices were randomised to intervention and 15 to the control group after stratifying for baseline vaccination rate. All intervention practices were offered and received an educational outreach visit to primary healthcare teams, in addition to audit and feedback directed at improving influenza and pneumococcal vaccination rates in high-risk groups. Control practices received audit and feedback alone. All practices measured influenza and pneumococcal vaccination rates in high-risk groups. Primary outcomes were improvements in vaccination rates in patients aged 65 years and over, and patients with coronary heart disease (CHD), diabetes and a history of splenectomy.*

Results: *Improvements in pneumococcal vaccination rates in the intervention practices were significantly greater compared with controls in patients with CHD, 14.8% versus 6.5% (odds ratio [OR] = 1.23, 95% confidence interval [CI] = 1.13 to 1.34) and diabetes, 15.5% versus 6.8% (OR = 1.18, 95% CI = 1.08 to 1.29) but not splenectomy, 6.5% versus 4.7% (OR = 0.96, 95% CI = 0.65 to 1.42). Improvements for influenza vaccination were also usually greater in intervention practices but did not reach statistical significance. The increases for influenza vaccination in intervention versus control practices were for CHD, 18.1% versus 13.1% (OR = 1.06, 95% CI = 0.99 to 1.12); diabetes, 15.5% versus 12.0% (OR = 1.07, 95% CI = 0.99 to 1.16), splenectomy 16.1% versus 2.9% (OR = 1.22, 95% CI = 0.78 to 1.93); and those over 65 years 20.7% versus 25.4% (OR = 0.99, 95% CI = 0.96 to 1.02).*

Conclusion: *Practices where primary care teams received an educational outreach visit demonstrated a significantly greater improvement in uptake in high-risk groups for pneumococcal but not influenza vaccine.*

Keywords: *randomised controlled trial; influenza vaccination; pneumococcal vaccination.*

A N Siriwardena, MB, MMedSci, FRCGP, clinical research fellow; A Rashid, MD, FRCGP, head of division, Primary Care, Department of Health and Community Studies; M R D Johnson, PhD, associate director, Mary Seacole Research Centre, De Montfort University, Leicester. M E Dewey, PhD, senior lecturer and deputy director, Trent Institute, Queens Medical Centre, Nottingham.

Address for correspondence

Dr A N Siriwardena, North Dene, Langworth Road, Scothern, Lincoln LN2 2UP. E-mail: niro@siriwardena.freeserve.co.uk

Submitted: 30 October 2001; Editor's response: 16 January 2002; final acceptance: 25 March 2002.

Introduction

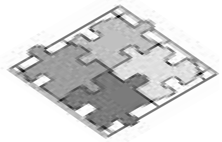
LIFELONG learning is a key component of clinical governance.[1] A major challenge for medical education is to translate learning into benefits for patients. This problem is neatly summarised in the concept of Miller's pyramid or the competence–performance gap.[2] The recent influential report on the future of continuing professional development in primary care suggested that greater emphasis should be placed on multidisciplinary practice-based learning to help address this.[3] Despite theoretical support from adult learning theory[4] that small group learning may improve the performance of primary healthcare teams and patient outcomes when relevant to practice and delivered at the workplace, there has been little research undertaken on the effectiveness of multidisciplinary education for primary healthcare teams in the United Kingdom.

One method that has been advocated — educational outreach (sometimes termed academic detailing) — has been shown to improve performance.[5] However, previous studies have been directed at single professional groups, usually general practitioners (GPs), rather than multidisciplinary practice teams and focused on process and prescribing, rather than patient outcomes.[6]

Influenza and pneumococcal vaccination are important preventive care measures to reduce morbidity and mortality in high-risk groups. There is good evidence for effectiveness of influenza vaccination from systematic reviews[7,8] and observational studies.[9] A systematic review of randomised and quasi-randomised designs also showed reduced risk of systemic infection from pneumococcal types included in pneumococcal vaccine, including elderly, institutionalised or high-risk patients.[10] Pneumococcal vaccination has also been shown to have effects additional to influenza vaccination in preventing pneumococcal bacteraemia,[11] particularly in high-risk groups.[12] There is good evidence from observational studies that it protects healthy adults against pneumonia and bacteraemia while protecting high-risk groups against bacteraemia,[13] hospitalisation, and death, with savings in direct medical costs.[14]

Despite recommendations for immunisation by the Department of Health,[15] there is evidence of poor coverage of these high-risk groups. The government target set in 2000–2001 was to immunise 60% of patients over 65 years of age and also those under 65 in high-risk groups each year against influenza. Current guidance also recommends immunisation of high-risk patients with pneumococcal vaccine because of the similarities in indications for the two vaccines.[15] Previous studies and audits have shown that fewer than a quarter of those at risk are being vaccinated against

HOW THIS FITS IN



What do we know?

There is a lack of evidence on the effectiveness of educational outreach to primary healthcare teams to improve performance and patient outcomes. Little is known about the uptake of influenza and pneumococcal vaccinations in high-risk groups in UK general practice and methods to improve this.

What does this paper add?

This study shows that practices, where primary care teams received an educational outreach visit in addition to audit and feedback, demonstrated a significantly greater uptake in high-risk groups for pneumococcal but not influenza vaccine, compared with practices who received audit and feedback alone.

influenza.[16] There are even lower observed rates for pneumococcal vaccination[17-19] and this may be because of lower awareness among patients,[20] poorer acceptance by doctors, and fewer practice policies for delivery.[21,22]

A cluster randomised controlled trial was conducted to assess the effect of an educational outreach visit to primary healthcare teams on influenza and pneumococcal vaccination rates.

Method

Recruitment of practices

All practices in West Lincolnshire Primary Care Trust (*n* = 39) and Trent Focus Collaborative Research Network (*n* = 50) were invited to participate in the study in June 2000. Twenty practices from the PCT and ten practices from the research network agreed to participate and all subsequently undertook the study. The involvement of practices in the trial is summarised in Figure 1.

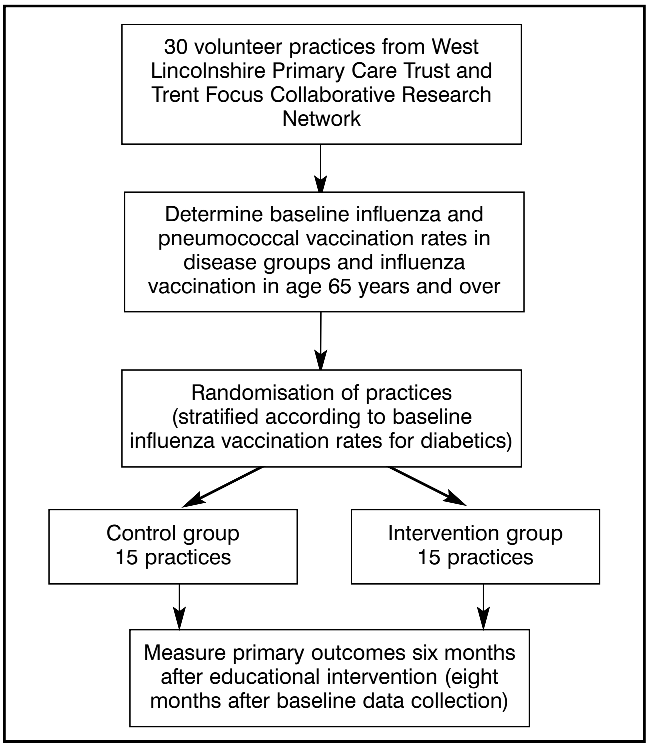


Figure 1. Flow chart summarising involvement of practices in trial.

Baseline data collection

The initial baseline data collection was carried out in August 2000 with 30 practices. The data collection method had been previously piloted in both a single practice[22] and a county-wide study.[23] The data collection was carried out by Lincolnshire Primary Care Audit Group (PCAG) on behalf of the PCT as part of a multipractice audit[24] and, additionally, one of the authors for the Collaborative Research Network practices. Practices were asked to collect vaccination data for those aged 65 years and over, and patients with coronary heart disease (CHD), diabetes or a previous splenectomy using Read codes. These tracer conditions were chosen to reflect vaccine uptake in target groups because they were relatively clearly defined and the most accurately recorded of the high-risk conditions on practice disease registers.[25] Although chronic heart disease is more usually stated as a risk group for pneumococcal vaccination, most patients with heart failure (which is usually taken to mean chronic heart disease) have coronary disease. Heart failure registers are unreliable in general practice because of misdiagnosis, either as false positives[26] or underdiagnosis[27,28] and so CHD was used as a proxy. For patients aged 65 years and over and in each disease group, participating practices recorded if patients had received influenza vaccination in the previous year or, for disease groups only, pneumococcal vaccination ever. To ensure patient confidentiality, practices completed these data collection forms using patient identification numbers only and held the patient reference sheet with names of patients against those numbers. Practices used their own staff to collect data on pre-printed forms, with clear instructions about how this should be done, and sent these to the PCAG for analysis. Alternatively, practices sent details of number vaccinated and denominators for each target group obtained from searching the practice computer database. Data were analysed to produce summary data, graphs, and results for initial feedback to practices.

Randomisation

Randomisation was carried out in September 2000. Because the target of the intervention and therefore the unit of randomisation was the practice, cluster-randomised methodology was used.[29,30] There is evidence that the capacity for a practice to increase immunisation rate depends on its baseline rate, i.e. it is easier to increase from a low baseline than a high one. Because of this ceiling effect,[31] it was agreed to use stratified randomisation based on initial rate. Baseline influenza vaccination rate was chosen for diabetes as the stratifying variable (all the rates were correlated). Within strata, practices were randomly allocated to intervention or control.

Intervention

The intervention was an educational outreach visit to practice teams based on the principles of academic detailing.[5,32] The visit took place at the practice, lasted no longer than one hour, and often took place during a primary health care team meeting, at which at least one GP, practice nurse, and practice manager (but often the majority of the primary care team) were present. The educational visit was delivered by one of the research team — a GP — who provided evidence-based information, presenting both sides of controversial issues, encouraging active learning, using simple overheads and graphs and emphasising the essential messages. The educational element of this method was a dialogue around perceived barriers to vaccination within the organisation. Feedback of practice vaccination rates in relation to other practices in the study and national targets was then provided. Following this there was a discussion about current practice policy and techniques employed to improve adult vaccination rates, with a summary of the evidence of effective interventions emphasising patient reminders and recall,[33] professional recommendation,[34] reminder systems,[35] audit and feedback,[36] and a team approach. Control practices undertook baseline data collection and received written feedback on their vaccination rates compared with other participating practices. Both intervention and control practices undertook a follow-up data collection six months after the educational intervention, which took place at the start of the annual influenza vaccination campaign in October 2000.

Study outcomes

The study outcomes were vaccination rates by practices for patients aged 65 years and over, and patients with CHD, diabetes, and splenectomy, six months after the educational outreach visit. The groups were treated separately for the analysis although they were overlapping. Practices were also surveyed, using a semi-structured questionnaire, to find out what existing and new strategies had been used to improve vaccination rates.

Sample size

Sample size was calculated with vaccination rate per practice as the primary outcome. Using preliminary data from an interpractice audit of vaccination uptake conducted by Lincolnshire PCAG in 1998, where practices achieved an increase in uptake of 10% for influenza vaccination and between 10% and 15% for pneumococcal vaccination in patients with CHD and diabetes with audit and feedback, we estimated control rates and standard deviations of these rates. An increase in vaccination uptake of 20% was chosen to move vaccination rates towards or above the government target of 65% for influenza vaccination. To detect a difference between control rates and the desired targets of at least one standard deviation, using the Student's *t*-test with power 0.8 and size 0.05, would require 17 practices per group. However, with most of the comparisons being the effects of at least 1.5 standard deviations, we calculated that nine practices per group would be required to detect this difference with the same power.

Statistical methods

Data analysis was carried out using the Egret and SPSS (version 10)[37] statistical software packages. Poisson regression was used to detect significant differences between intervention and control groups in vaccination rate change, using population at risk as an offset and taking account of the stratification. Rates were expressed as mean vaccination rates, odds ratios, and confidence intervals.

Ethical approval

Ethical approval was obtained for the study from Trent Multicentre Research Ethics Committee. The study was also approved by Trent Focus Collaborative Research Network and consent was obtained from individual general practices.

Results

Thirty practices took part in the study. Participating practices were similar to non-participating practices with respect to partnership size, list size, dispensing status, and rurality (Table 1). Practices were randomised to intervention or control groups depending on their baseline vaccination rate for influenza vaccination in diabetic patients (as baseline rates for each vaccination and risk group were correlated) so that baseline vaccination rates were similar for both groups. Baseline characteristics of intervention and control practices were also similar in respect of numbers of partners, list size, rurality, and prevalence of coronary heart disease, diabetes, splenectomy, and patients aged 65 years and over (Table 2). Intervention practices were significantly more likely to be non-dispensing.

Practices in both study groups were also similar in their stated strategies for improving vaccination uptake at baseline. This was assessed by means of a postal questionnaire to each practice. Items included questions on strategies that were likely to improve influenza and pneumococcal vaccination rates, such as practice guidelines on vaccination, discussion within primary care teams, disease and vaccine registers, patient reminders (poster campaigns, prescription reminders, call and recall letters) and organisational policies (dedicated vaccine refrigerators, vaccination clinics, stock control systems, and previous audit of vaccination uptake [data available from the authors on request]).

Practice performance was compared at baseline (August 2000) and six months after the educational intervention took

Table 1. Characteristics of participating compared with non-participating practices.

Characteristics	Participating practices (n = 30)	Non-participating practices (n = 62)	χ^2
Practice			
TFCRN[a]	10	42	P = 0.002
WLPCT[b]	20	20	
Number of partners			
1	6	10	
2–3	14	22	P = 0.38
4–6	7	26	
7+	3	4	
List size			
<3000	7 (23.2)	8 (12.9)	
3000–5999	11 (36.7)	18 (29.0)	P = 0.39
6000–8999	8 (26.7)	23 (37.1)	
≥9000	4 (13.3)	13 (21.0)	
Dispensing	13 (43.3)	16 (25.8)	P = 0.46
Location			
Rural or semi-rural	12 (40.0)	16 (25.8)	
Suburban or city	18 (60.0)	46 (74.2)	P = 0.17

[a]Trent Focus Collaborative Research Network; [b]West Lincolnshire Primary Care Trust.

Table 2. Characteristics of study practices.[a]

Characteristics	Intervention practices $n = 15$ (%)	Control practices $n = 15$ (%)
Practice		
TFCRN[b]	5	5
WLPCT[c]	10	10
Number of partners		
1	2	3
2–3	7	5
4–6	6	3
7+	0	3
List size		
<3000	2 (13)	5 (33)
3000–5999	7 (47)	4 (27)
6000–8999	5 (33)	3 (20)
>9000	1 (7)	3 (20)
Dispensing	2	9
Location		
Rural or semi-rural	4	10
Suburban or city	11	5
Prevalence (%)		
CHD	3.66	3.60
Diabetes	2.38	2.52
Splenectomy	0.076	0.11
Aged over 65	16.1	15.9

[a]There were no significant differences between intervention and control groups using χ^2 except for dispensing status in control practices ($P = 0.023$, Yates corrected); [b]Trent Focus Collaborative Research Network; [c]West Lincolnshire Primary Care Trust.

place. The educational visit was carried out in October 2000, two months after the baseline assessment and at the beginning of the influenza vaccination campaign. Only one control practice did not submit data for splenectomy patients. Improvements in vaccination uptake occurred in CHD, diabetic, and splenectomy patients for both vaccinations and in both intervention and control groups. Baseline uptake was lower for pneumococcal vaccination than influenza vaccination. Median targets set by practices for the audit were at or higher than national targets for patients aged 65 years and over. Significant improvements occurred in the intervention group, compared with the control group, for pneumococcal vaccination in CHD and diabetic patients (Table 3).

A semi-structured questionnaire after the visit showed the range of approaches by which practices augmented their existing organisational strategies (Figure 2). This included awareness raising through poster campaigns and information leaflets in the waiting room, as well as patient reminders and media campaigns (both local and national) for influenza. The education and training to practice teams also encouraged practitioner reminders, such as templates and vaccine prompts, to trigger health professionals into advising high-risk patients to be immunised. Finally, practice systems were also changed to improve vaccination rates using more efficient vaccine supply and storage, risk registers and call–recall systems, better access through special clinics, home vaccination for the housebound by community staff, and vaccine clinics in nursing homes.

Discussion

We were able to show that educational outreach to primary healthcare teams improved pneumococcal vaccination rates in coronary and diabetic patients in this trial. We were unable to demonstrate an improvement in influenza vaccination rates or vaccination rates in splenectomy patients as a result of the intervention although rates were generally better in the intervention practices, except for those aged 65 years and above. The most likely explanation for this, given the marked increase in vaccination rates in both the intervention and control groups, was that the national and local campaigns for influenza vaccination linked to financial incentives for GPs — which coincided with this study — were successful in improving uptake and may have swamped any effect of the educational visit. Splenectomy patients, who were numerically a small group, had a much greater vaccination rate at baseline, particularly for pneumococcal vaccination, possibly because of the medicolegal imperative to vaccinate, and as a result our study was underpowered to demonstrate significant improvements in this subset. The results described are likely to be valid because of the careful design of the study,[38,39] randomisation by practice dependent on baseline immunisation rates, analysis of clusters, and the absence of dropouts.

This study lends support to the trend towards practice-based multidisciplinary education for general practice teams as a method of improving delivery of care and outcomes for patients. This is likely to be particularly so where an intervention involves more than one professional group or benefits from a team approach. Practice-based education has been shown to improve the process of care in some studies,[40] whereas this study has demonstrated improvement in one particular outcome of care, specifically pneumococcal vaccination rates in high-risk groups.

Although the evidence is largely in favour of educational outreach, some studies have not found this to be the case. Watson *et al* found that inhouse education did not improve referral decisions for genetic counselling over and above an information pack, although it did increase practitioner confidence.[41] Gomel *et al* found inhouse education more costly than the alternative of telemarketing to improve screening for problem drinkers.[42] In another study, academic detailing failed to show a sustained benefit for management of depression.[43] More recently, Baker *et al* showed that using educational methods that addressed barriers to change could be effective in modifying individual practitioner behaviour and patient outcomes for managing depression.[44] They went on to suggest that addressing obstacles to change at team and organisational levels may also be important, an aspect which we tried to address in this study. Another notable aspect of our study was the short duration of the educational intervention compared with some other studies that have used repeated education over several weeks; for example, to improve adolescent health care.[45] However, the study does not, and did not set out to, compare the benefits of uniprofessional versus team-based education, and this may be a potential area for future study.

Readiness to change is an important factor leading to change[46] and practices that participated in this study may have been more willing to adopt these particular interventions, to improve immunisation uptake. Identifying barriers to change has been shown to be important[47] and effective in changing doctors' reported behaviour.[48] The educational visit focused on overcoming individual, team, and organisational barriers to change. Practice teams identified a number of barriers to implementing their immunisation programmes that had been recognised in previous studies. These included

Table 3. Improvement in vaccination uptake of intervention and control practices at baseline and six months after the educational intervention.

Patients (*n*) in each group at Phase 2	Vaccination uptake (%)		Median standard set (Phase 1, 2)	Mean improvement (%)	Odds ratio[a] (95% CI)	*P*-value
	Phase 1	Phase 2				
Influenza vaccination uptake in CHD						
Intervention (*n* = 3025)	58.0	76.1	70,70	18.1	1.06	0.09
Control (*n* = 3182)	59.4	72.5	70,75	13.1	(0.99–1.12)	
Influenza vaccination uptake in diabetes						
Intervention (*n* = 2059)	58.9	74.4	70,75	15.5	1.07	0.08
Control (*n* = 2268)	58.2	70.2	70,80	12.0	(0.99–1.16)	
Influenza vaccination uptake in splenectomy						
Intervention (*n* = 62)	64.5	80.6	100,100	16.1	1.22	0.38
Control (*n* = 107)	55.1	58.0	100,100	2.9	(0.78–1.93)	
Influenza vaccination uptake at age 65 years and over						
Intervention (*n* = 13 633)	48.6	69.3	60,60	20.7	0.99	0.42
Control (*n* = 13 947)	44.7	70.1	60,60	25.4	(0.96–1.02)	
Pneumococcal vaccination uptake in CHD						
Intervention (*n* = 3025)	30.6	44.8	70,70	14.8	1.23	<0.001
Control (*n* = 3182)	33.2	39.7	70,70	6.5	(1.13–1.34)	
Pneumococcal vaccination uptake in diabetes						
Intervention (*n* = 2059)	43.3	58.8	70,70	15.5	1.18	<0.001
Control (*n* = 2268)	40.6	47.4	70,75	6.8	(1.08–1.29)	
Pneumococcal vaccination uptake in splenectomy						
Intervention (*n* = 62)	79.0	85.5	100,100	6.5	0.96	0.83
Control (*n* = 107)	86.0	90.7	100,100	4.7	(0.65–1.42)	

[a]From the Poisson regression controlling for initial level and stratification.

Awareness raising
- Posters and leaflets in waiting rooms
- Reminders to all at-risk, previous non-attenders, defaulters (post, telephone, repeat prescription)
- Media campaigns

Prompts and advice
- Recommendation and advice: repeated, consistent
- Posters and patient information leaflets (PILs) in consulting rooms
- Vaccine markers (computer, manual), disease management template reminders
- Education, teamwork

Policy
- Protocols and audit
- Accurate age–sex, disease and vaccine registers
- Call–recall and tracking systems
- Targeting underperformance
- Funding: item of service, target payment

Vaccines
- Supply
- Storage
- Stock control and claims

Improved access
- Vaccine clinics: appointments, open access, weekend or evening clinics
- Disease days
- Chronic disease clinics
- Home visits (district nurses, health visitors)
- Nursing homes

Figure 2. Techniques employed by practices to improve influenza and pneumococcal vaccination rates.

barriers relating to patients (lack of awareness, failure to self-identify as high risk, fear of side effects including contracting influenza or doubts about effectiveness); barriers arising from practitioners (lack of awareness, doubts about effectiveness, missed opportunities to vaccinate because of workload or lack of appropriate systems); and practice or system factors (including lack of reminders, protocols, audit, feedback, call and recall, vaccine supply storage and stock control and access). The use of multifaceted interventions directed at many or all of these barriers has been suggested to be more likely to lead to change and this strategy was used and encouraged in this study.[49]

The costs of the intervention were not formally evaluated. Costs to the practice included time for team members to meet with the outreach visitor but this was minimised by integrating visits into primary healthcare team meetings. Other costs included time to prepare the educational intervention to practices (at the rate of three-hour preparation time overall), travel, and an hour per practice for delivery. Further work needs to be done to address the cost effectiveness of this approach. It may be argued that the incentive payments for influenza introduced by the government and previously used successfully in the United States[50] were more effective at improving influenza immunisation rates, but it is not clear whether this may have been at a higher cost than the effect of the educational intervention on pneumococcal vaccination.

This study demonstrates that education delivered to practice teams, addressing areas relevant to practice and using audit, feedback, discussion of barriers to change and how to overcome these, may lead to improved outcomes for patients. This should be encouraged as a method of continuing professional development. Workforce confederations need to consider how to resource this type of learning.

References

1. Department of Health. *A first class service — quality in the new NHS*. London: DoH, 1998.
2. Miller GE. The assessment of clinical skills/competence/performance. *Acad Med* 1990; **65:** S63-S67.
3. Department of Health. *A review of continuing professional development in general practice: a report by the Chief Medical Officer*. London: DoH, 1998.

4. Knowles MS. *Adult learner: a neglected species*. Houston, TX: Gulf Publishing, 1990.
5. Thomson O'Brien MA, Oxman AD, Davis DA, *et al*. Educational outreach visits: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2000; CD000409.
6. Fender GR, Prentice A, Gorst T, *et al*. Randomised controlled trial of educational package on management of menorrhagia in primary care: the Anglia menorrhagia education study. *BMJ* 1999; **318:** 1246-1250.
7. Gross PA, Hermogenes AW, Sacks HS, *et al*. The efficacy of influenza vaccine in elderly persons. A meta-analysis and review of the literature. *Ann Intern Med* 1995; **123:** 518-527.
8. Demicheli V, Jefferson T, Rivetti D, Deeks J. Prevention and early treatment of influenza in healthy adults. *Vaccine* 2000; **18:** 957-1030.
9. Fleming DM, Watson JM, Nicholas S, *et al*. Study of the effectiveness of influenza vaccination in the elderly in the epidemic of 1989-1990 using a general practice database. *Epidemiol Infect* 1995; **115:** 581-589.
10. Hutchison BG, Oxman AD, Shannon HS, *et al*. Clinical effectiveness of pneumococcal vaccine. Meta-analysis. *Can Fam Physician* 1999; **45:** 2381-2393.
11. Honkanen PO, Keistinen T, Miettinen L, *et al*. Incremental effectiveness of pneumococcal vaccine on simultaneously administered influenza vaccine in preventing pneumonia and pneumococcal pneumonia among persons aged 65 years or older. *Vaccine* 1999; **17:** 2493-2500.
12. Koivula I, Sten M, Leinonen M, Makela PH. Clinical efficacy of pneumococcal vaccine in the elderly: a randomized, single-blind population-based trial. *Am J Med* 1997; **103:** 281-290.
13. Nguyen-Van-Tam JS, Neal KR. Clinical effectiveness, policies, and practices for influenza and pneumococcal vaccines. *Semin Respir Infect* 1999; **14:** 184-195.
14. Nichol KL, Baken L, Wuorenma J, Nelson A. The health and economic benefits associated with pneumococcal vaccination of elderly persons with chronic lung disease. *Arch Intern Med* 1999; **159:** 2437-2442.
15. Begg NT, Salisbury DM (eds). *Immunisation against infectious diseases*. London: HMSO, 1996.
16. Watkins J. Effectiveness of influenza vaccination policy at targeting patients at high risk of complications during winter 1994-1995: cross sectional survey. *BMJ* 1997; **315:** 1069-1070.
17. McDonald P, Friedman EH, Banks A, *et al*. Pneumococcal vaccine campaign based in general practice. *BMJ* 1997; **314:** 1094-1098.
18. Sheikh A. Pneumococcal vaccination: a practice-based audit. *Audit Trends* 1998; **6:** 93-95.
19. Doherty MJ, Greenstone MA, Meigh R. Pneumococcal vaccine campaign based in general practice. Small audit showed that only 14% of patients were offered pneumococcal vaccine. *BMJ* 1997; **315:** 816.
20. Findlay PF, Gibbons YM, Primrose WR, *et al*. Influenza and pneumococcal vaccination: patient perceptions. *Postgrad Med J* 2000; **76:** 215-217.
21. Kyaw MH, Bramley JC, Chalmers J, *et al*. Pneumococcal vaccination: opinion of general practitioners and hospital doctors in Scotland, 1999-2000. *Commun Dis Public Health* 2001; **4:** 42-48.
22. Siriwardena AN. Targeting pneumococcal vaccination to high-risk groups: a feasibility study in one general practice. *Postgrad Med J* 1999; **75:** 208-212.
23. Siriwardena AN, Hazelwood L, Wilburn T, *et al*. Improving influenza and pneumococcal vaccination uptake in high-risk groups in Lincolnshire: a quality improvement report. *Submitted for publication* the *Journal of Clinical Governance, in* 2002.
24. Siriwardena AN, Wilburn T, Hazelwood L. Increasing influenza and pneumococcal vaccination rates in high risk groups in one primary care trust. *British Journal of Clinical Governance* 2001 (in press).
25. Kessner DM, Kalk CE, Singer J. Assessing health quality — the case for tracers. *N Engl J Med* 1973; **288:** 189-194.
26. Remes J, Miettinen H, Reunanen A, Pyorala K. Validity of clinical diagnosis of heart failure in primary health care. *Eur Heart J* 1991; **12:** 315-321.
27. Sutton GC. Poole-Wilson PA. The prevalence, aetiology, and management of heart failure. *Br J Gen Pract* 1996; **46:** 551.
28. Morgan S, Smith H, Simpson I, *et al*. Prevalence and clinical characteristics of left ventricular dysfunction among elderly patients in general practice setting: cross-sectional survey. *BMJ* 1999; **318:** 368-372.
29. Bland JM, Kerry SM. Statistics notes. Trials randomised in clusters. *BMJ* 1997; **315:** 600.
30. Campbell MK, Mollison J, Steen N, *et al*. Analysis of cluster randomized trials in primary care: a practical approach. *Fam Pract* 2000; **17:** 192-196.
31. Gyorkos TW, Tannenbaum TN, Abrahamowicz M, *et al*. Evaluation of the effectiveness of immunization delivery methods. *Can J Public Health* 1994; **85 (Suppl 1):** S14-S30.
32. Soumerai SB, Avorn J. Principles of educational outreach ('academic detailing') to improve clinical decision making. *JAMA* 1990; **263:** 549-556.
33. Szilagyi PG, Bordley C, Vann JC, *et al*. Effect of patient reminder/recall interventions on immunization rates: a review. *JAMA* 2000; **284:** 1820-1827.
34. Kyaw MH, Nguyen-Van-Tam JS, Pearson JC. Family doctor advice is the main determinant of pneumococcal vaccine uptake. *J Epidemiol Community Health* 1999; **53:** 589-590.
35. Austin SM, Balas EA, Mitchell JA, Ewigman BG. Effect of physician reminders on preventive care: meta-analysis of randomized clinical trials. *Proc Ann Symp Comput Appl Med Care* 1994; 121-124.
36. Thomson O'Brien MA, Oxman AD, Davis DA, *et al*. Audit and feedback: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2000; CD000259.
37. Norusis MJ. *SPSS base manual 4.0*. Chicago, IL: SPSS Inc, 1990.
38. Education Group for Guidelines on Evaluation. Guidelines for evaluating papers on educational interventions. *BMJ* 1999; **318:** 1265-1267.
39. Begg C, Cho M, Eastwood S, *et al*. Improving the quality of reporting of randomized controlled trials. The CONSORT statement. *JAMA* 1996; **276:** 637-639.
40. Feder G, Griffiths C, Highton C, *et al*. Do clinical guidelines introduced with practice-based education improve care of asthmatic and diabetic patients? A randomised controlled trial in general practices in east London. *BMJ* 1995; **311:** 1473-1478.
41. Watson E, Clements A, Yudkin P, *et al*. Evaluation of the impact of two educational interventions on GP management of familial breast/ovarian cancer cases: a cluster randomised controlled trial. *Br J Gen Pract* 2001; **51:** 817-821.
42. Gomel MK, Wutzke SE, Hardcastle DM, *et al*. Cost-effectiveness of strategies to market and train primary health care physicians in brief intervention techniques for hazardous alcohol use. *Soc Sci Med* 1998; **47:** 203-211.
43. Lin EH, Katon WJ, Simon GE, *et al*. Achieving guidelines for the treatment of depression in primary care: is physician education enough? *Med Care* 1997; **35:** 831-842.
44. Baker R, Reddish S, Robertson N, *et al*. Randomised controlled trial of tailored strategies to implement guidelines for the management of patients with depression in general practice. *Br J Gen Pract* 2001; **51:** 737-741.
45. Sanci LA, Coffey CM, Veit FC, *et al*. Evaluation of the effectiveness of an educational intervention for general practitioners in adolescent health care: randomised controlled trial. *BMJ* 2000; **320:** 224-230.
46. Cohen SJ, Halvorson HW, Gosselink CA. Changing physician behavior to improve disease prevention. *Prev Med* 1994; **23:** 284-291.
47. Grol R. Beliefs and evidence in changing clinical practice. [Personal paper.] *BMJ* 1997; **315:** 418-421.
48. Cranney M, Barton S, Walley T. Addressing barriers to change: an RCT of practice-based education to improve the management of hypertension in the elderly. *Br J Gen Pract* 1999; **49:** 522-526.
49. Hulscher ME, Wensing M, van der WT, Grol R. Interventions to implement prevention in primary care (Cochrane Review). *Cochrane Database Syst Rev* 2001; **1:** CD000362.
50. Kouides RW, Bennett NM, Lewis B, *et al*. Performance-based physician reimbursement and influenza immunization rates in the elderly. The Primary Care Physicians of Monroe County. *Am J Prev Med* 1998; **14:** 89-95.

Acknowledgements

We thank West Lincolnshire Primary Care Trust and the Trent Focus Collaborative Research Network of practices who participated in this study, and Lincolnshire Primary Care Audit Group for help with the data collection and feedback to practices. Dr Siriwardena was funded by Trent Focus and West Lincolnshire Primary Care Trust, and the PCAG was funded by Lincolnshire.