ECRONICON OPEN ACCESS

EC MICROBIOLOGY
Research Article

Interventions to Improve Pneumococcal Vaccination

Abbas Mohammadnoor Yehya Halawani[1]*, Ahdab Hassan Satiqun[2], Sofyan Osama Faidah[3], Bodoor Abdullah Ali Amrah[4], Mohammad Ghazi Alharbi[1], Saad Hussain Alsharif[5], Bashayer Saad Hamoud Al Sultan[4], Omar Salem Al Qasem[6], Maram Mubarak Barkoot[4], Jawahir Ali Jaber[4], Alruwaili Fahad Saleh H[7], Ibtihal Hassan Ali Hadi[8], Asmaa Turki Altowairqi[2], Yousef Safar Alsahli[9] and Abdulrahman Almathna Ali Bajawi[3]

[1]Umm Al-Qura University, Mecca, Saudi Arabia

[2]Taif University, Taif, Saudi Arabia

[3]Ibn Sina National College, Jeddah, Saudi Arabia

[4]King Khalid University, Abha, Saudi Arabia

[5]Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia

[6]King Faisal University, Saudi Arabia

[7]Al Jouf University, Sakakah, Saudi Arabia

[8]Jazan University, Jizan, Saudi Arabia

[9]PHC, Saudi Arabia

***Corresponding Author**: Abbas Mohammadnoor Yehya Halawani, Umm Al-Qura University, Mecca, Saudi Arabia.

Received: July 04, 2017; **Published:** July 07, 2017

Abstract

Background: *Streptococcus pneumoniae* is a precarious pathogen that could result in a wide spectrum of diseases, most dangerously invasive diseases such as sepsis, meningitis, and pneumonia. It's is highest in the youngest and oldest sections of the population in both more and less developed countries. The treatment of pneumococcal infections is complicated due to their resistance to penicillin and other antibiotics. Pneumococcal disease is preceded by asymptomatic colonization, which is especially high in children. The current seven-valent conjugate vaccine has proven to be effective against invasive disease caused by the vaccine-type strains, however interventions are in place to improve the effectiveness of pneumococcal vaccination especially in elderlies.

Objective of the Study: Objective of the Study was to systematically review the effectiveness of quality improvement interventions for increasing the rates of influenza and pneumococcal vaccinations among adults.

Methods: A Systematic search.

Results: The search yielded nine studies including 11780 patients, 4065/7715 female to male ratio and average age of 53.3 years. Most studies involved elderly primary care patients. Interventions were associated with improvements in the rates of any vaccination (pooled odds ratio [OR] = 1.73, $P < 0.001$), pneumococcal (20 comparisons, 9 studies, OR = 2.05, 95% CI, 1.83-2.41). Interventions that appeared effective were clinician reminders, team change, patient outreach, clinician education. Patient outreach was more effective if personal contact was involved. Team changes were more effective where nurses administered pneumococcal vaccinations independently. Study quality varied but was not associated with outcomes.

Conclusion: Quality improvement interventions, such as clinician reminders and education, team change and patient outreach particularly where vaccination responsibilities is assigned to a non-physician personnel or that activate patients through personal contact, can significantly improve vaccination rates in adults particularly elderly patients which are considered a target group for S. Pneumonia invasive diseases. Nevertheless, on order to meet more potent interventions to meet national policy targets, stronger interventions should be innovated and implemented.

Keywords: *Pneumococcal; Quality Improvement; Vaccination; Streptococcus pneumonia; Primary Health Care*

Introduction

Streptococcus pneumoniae (*pneumococcus*) can cause a wide spectrum of diseases, the bacterium that is the most common cause of severe pneumonia, kills a half million children annually before their fifth birthday [1]. *Pneumococcus* also causes sepsis and meningitis and is one of the leading causes of bacterial otitis media (OM). In addition, *pneumococcus* causes significant morbidity and mortality in elderly adults [2].

Nevertheless , Pneumococcal diseases are particularly seen with highest incidence in infants < 2 years of age and young children, older adults (≥ 65 years of age) especially in those who have already significant comorbidities, and persons with conditions that affect their ability to make antibody to capsular polysaccharides specifically those with a compromised immune system (e.g. solid organ transplantation, multiple myeloma, HIV infection), Patients with chronic lung disease are at increased risk for pneumococcal pneumonia, and patients with conditions such as heart failure are more likely to have adverse outcomes if pneumonia occurs. Asplenia greatly increases the risk for overwhelming pneumococcal sepsis, and cerebrospinal fluid leak or a cochlear implant greatly increases the risk for meningitis.

Moreover, some studies have shown that 36% to 70% of patients admitted to hospital with invasive pneumococcal infection had been inpatients in the five years prior to admission [3]. Pneumococcal vaccination is recommended for all children and for adults who have a condition that places them at increased risk for developing pneumonia or invasive pneumococcal disease or for having a serious outcome should pneumonia develop [4].

Clinical practice guidelines have recommended routine pneumococcal vaccinations for elderly and nonelderly high-risk patients [5]. Even so, vaccination rates remain low [6]. Brull., *et al*. demonstrated that pneumococcal vaccine is the most commonly overlooked preventive health intervention among medial patients who are discharged from a tertiary care hospital [7]. Studies of interventions for improving adult influenza and pneumococcal vaccination rates are numerous and have been synthesized in several systematic reviews. Jacobson and Szilagyi [8] found that patient reminder and recall systems improved vaccination rates. The US Preventive Services Task Force's (USPSTF) Community Guide to Preventive Services found supporting evidence for numerous interventions aimed at universally recommended vaccines and for combinations of multiple interventions for vaccines targeted to high-risk groups [9]. Another study showed that a computerized reminder system in a teaching hospital resulted in a pneumococcal vaccination rate of 35.8% of eligible patients compared to 0.8% in the control group [10]. Many hospitals do not have specialized computer systems such as that described in this study, therefore the generalizability of the study is limited.

Stone., *et al*. found that interventions involving organizational changes and teamwork were most effective for improving pneumococcal vaccination rates [11]. Most recently, Thomas., *et al*. found evidence of moderate quality that increasing community demand, vaccinating seniors during home visits, and deploying prevention facilitators working with health professionals improved influenza vaccination rates [12].

In the present review, we systematically reviewed previous quality improvement studies on the efficacy of the interventions intended to improve pneumococcal vaccines for a comprehensive assessment.

Materials and Methods

Literature Search

We searched the electronic medical literature databases listed below for English literature with relevant study cohort and outcomes.

Data Sources: PubMed/MEDLINE, Scopus, The Cochrane Library, EMBASE, and Google Scholar from 1980 to 2017.

Search terms included Pneumococcal Vaccination AND Interventions AND Risk group OR Elderly in combination with systematic review or meta-analysis.

Study Selection

Search results were screened by scanning abstracts for the following:

Inclusion Criteria

1. Study design: RCTs, Cluster RCTs or CCTs that featured a parallel control group.
2. Language: English
3. Articles published between 1995 and 2017
4. Gender: both males and females were included
5. Target Age group: elderly adults or adults with chronic disease.
6. Condition/Symptoms: Articles evaluated an intervention to deliver pneumococcal vaccination in a population at risk, or included information on risk populations (subsets) as part of a larger vaccination effort
7. Outcome measurements included follow up.
8. Studies reporting sufficient data to estimate log odds ratios (ORs) and P values eligible for meta-analysis.

Exclusion Criteria

1. Studies with Irrelevant outcomes/endpoint.
2. Studies targeting different age groups (infants rather than adults).
3. Articles not published in English

Data Synthesis

1. Intervention Groups: intervention aim and type are explained in Table 1.
2. Control Groups: representing the No intervention group where no intervention was deployed (a control intervention aimed at non-vaccination behaviors or a different intervention for improving vaccination rates) and only the Usual-care strategy and period were set for this group.

The usual care period consisted of an eight-week period where the medical students and residents were provided with a standardized form outlining eligibility for pneumococcal vaccination. These team members were responsible for assessment of patient eligibility, determining vaccination status and, if appropriate, ordering a dose of vaccine. However, no advice on how best to carry out these tasks was provided. The assigned coordinator determined vaccine eligibility and gathered information on previous vaccination status and whether or not a vaccine dose was ordered at the time a patient was discharged from hospital. This information was not provided to the medical students or residents.

Data extracted using a standard protocol concerning target population, sample size, intervention components, processes, and outcomes. Comparison among provider type was computation of differences between percent of successful program to number attempted.

Comparisons were included in meta-analyses if the control group was usual care; a control intervention aimed at non-vaccination behaviors or a different intervention for improving vaccination rates if the intervention was provided to both study arms. When study arms contributed to more than 1 comparison in a meta-analysis, the vaccination rate numerator and denominator were divided among the comparisons to avoid counting patients more than once.

Clinician reminders were stratified according to whether the reminder system was immunization specific or targeted a range of preventive care behaviors, and whether reminders were generated from patients' medical histories. Patient outreach interventions were stratified by communication medium.

Results

Study Selection

Electronic Searches identified 561 publications in addition to another 12 publications that were found through manual research. After removal of duplicates, abstracts and titles 311 publications were assessed as identified from title and abstract and 253 papers were excluded. 8 papers full text could not be retrieved and another 15 papers with the same cohort. There were also 19 papers excluded because they did not Interventions to Improve Pneumococcal Vaccination. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines in reporting the results [13] (Figure 1).

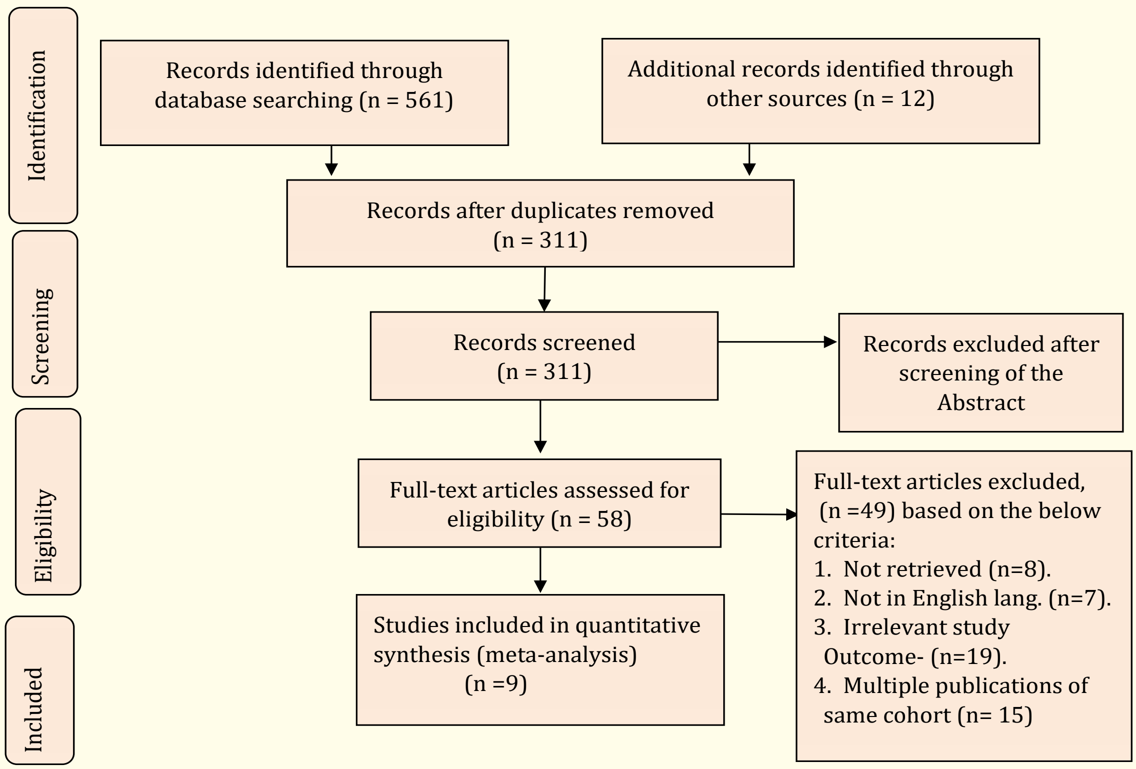

Figure 1: *PRISMA flow diagram showing the selection criteria of assessed the studies [13].*

Finally, 9 eligible articles 14-22 met the inclusion and exclusion criteria and detailed as the focus for the present study.

The search yielded nine studies including 11780 patients, 4065/7715 female to male ratio and average age of 53.3 years. Most studies involved elderly primary care patients. Characteristics of the studies, Eligibility criteria and study population data are detailed in Table 1.

There were 20 comparisons from 9 studies included in the meta-analyses.

The odds ratio for pneumococcal vaccinations, pooled across all interventions, was 2.05 (95% CI, 1.83 - 2.41; I^2 = 74%). Comparisons were available for clinician reminders, team change, patient outreach, clinician education and case management (OR = 1.18, 95% CI, 0.57 - 2.45; I^2 = 7%), which proved to be associated with improvements in vaccination rates. Highest odds ratio was triggered by Interventions featuring clinician reminders (OR = 2.28, 95% CI, 1.48 - 3.21; I^2 = 74%) followed by team change intervention (OR = 2.07, 95% CI, 1.51 - 2.84; I^2 = 50%) then comes after patient outreach intervention (OR = 1.78, 95% CI, 1.47-2.21; I^2 = 68%).

			Study population			
Authors	**Design**	**Location**	**no of patients**	**Group I F/M ratio**	**Age**	**Eligibility criteria**
Beck., *et al.* [14]	CCT	USA	Total = 321 Group I = 160 Control = 161	Group I = 110/50 Control = 103/58	Age (mean (sd)) Group I = 72 (sd not reported) Control = 75 (sd not reported)	Patients aged 65 years or older, with a chronic disease (heart, lung, joint, or diabetes).
Dalby., *et al.* [15]	RCT	Canada	Total = 142 Group I = 73 Control = 69	Group I = 52/21 Control = 43/26	Age (mean(sd)) Group I = 79.1 (5.8) Control = 78.1 (5.3)	Patients 70 years or older, reporting functional impairment, or admission to hospital, or bereavement in the previous 6 months.
Hermiz., *et al.* [16]	CCT	UK	Total = 177 Group I = 84 Control = 93	Group I = 43/41 Control = 50/43	Age (mean(sd)) Group I = 67.1 (sd not reported) Control = 66.7 (sd not reported)	Patients aged 30 to 80 years old, discharged to the community from emergency or in-patient care for COPD at the study hospital.
Apkon., *et al.* [17]	CCT	Location: United States (Kentucky and Florida)	Total = 1902 Group I = 936 Control = 966	Group I = 93/343 Control = 87/379	Age (mean(sd)) Group I = 34.4 (10.4) Control = 35.4 (11.0)	Patients aged 18 years or older, with scheduled appointments during the study period, who could speak and read English. Patients were excluded if they required emergency medical conditions or obstetric care; or if they had been previously exposed to the study intervention.
Berg., *et al.* [18]	RCS	USA	Total = 554 Group I = 277 Control = 2777	Group I = 32/145 Control = 38/139	Age (percent over 65): Group I = 21% Control = 22%	Heart failure patients continuously enrolled 12 months prior to and 12 months after the study intervention in a large MCO (Blue Cross).
Fishbein., *et al.* [19]	CBA	USA	300	70%/30%	Age (mean(sd)): 48 (sd not reported)	Patients aged 18 years or older, not acutely ill, providing written consent. Influenza and pneumococcal vaccinations were recommended for patients aged 65 years or older, or those with select chronic diseases.
Winston., *et al.* [20]	RCT	USA	Total = 6106 Group I = 1845 Control = 1866	Group I: 900/945 Control: 972/894	Age (mean(sd)): 53.8 (0.3)	Patients aged 65 years or over, or patients with chronic diseases. Eligible patients had no record of having received pneumococcal vaccination.
Harari., *et al.* [21]	RCT	UK	Total = 2006 Group I = 940 Control = 1066	Group I: 526/414 Control: 64/502	Age (mean(sd)) Group I = 74.7(6.3) Control = 74.2 (6.0)	Patients aged 65 years or older. Patients were excluded if they were nursing home residents, required help with activities of daily living, had dementia, had a terminal illness, or could not speak English.
Lennox., *et al.* [22]	Cluster RCT	Australia	Total = 272 Group I = 53 Group II = 57 Group III = 70 Control = 68	Group I: 21/32 Group II: 34/34 Group III: 27/43 Control: 12/29	Group I: 33 (11) Group II: 37 (12) Group III: 39 (14) Control: 34 (11)	Adults with an intellectual disability, living in a private residence with family, alone, or with other individuals in a shared arrangement.

Table 1: *Characteristics and study population of the included studies.*

Clinician education (OR = 1.51, 95% CI, 1.07 - 1.68; I^2 = 69%) and case management (OR = 1.36, 95% CI, 0.99-2.01; I^2 = 0%) were also associated with improvements in pneumococcal vaccination rates.

Interventions aim, type and meta-analysis outcome data are interpreted in table 2.

	Summary of Intervention		Results and Outcome			
Authors	**Aim**	**Intervention**	**Baseline**	**FU period**	**Follow-up (Cumulative)**	**Follow-up**
Beck., *et al.* [14]	Intervention aim: Improve preventive care	Group visits with a multidisciplinary care team vs usual care QI agent: Medical clinic Team change: The health care team was introduced at the first group visit. Pharmacists, dieticians, skilled nursing personnel, and a clinical psychologist were involved in facilitating and providing content for the group visits.	Group 1: 21/160 (13%) Control: 23/161 (14%)	Follow-up period: 1 year	Group 1: 53/160 (33%)* Control: 29/161 (18%)*	RR = 1.83, OR = 2.25, P < 0.001, *LTFU was 21/160 and 48/161 in the intervention and control groups, respectively. Differential LTFU may have resulted in bias in these results.
Dalby., *et al.* [15]	Intervention aim: Improve care of the elderly	Team change: A nurse visited the household of each community-dwelling elderly patient. Nurses provided influenza immunizations on home visits after the development of a care plan. nagement: Nurses reviewed each person's medical record and completed an assessment addressing physical, cognitive, emotional and social function, medication use, and safety and suitability of the home environment. A care plan was developed with the primary care physician, the patient, the patient's family, caregivers, and other health care professionals. The intervention adhered to the "functional consequences theory" of gerontologic nursing, and aimed at minimizing the negative effects of age-related changes and promoting positive function. Follow-up visits and phone calls were provided as needed over 14 months. Nurses played an important role in integrating health and community services.	Not clear	Follow-up period: 14 months	Group 1: 48/59 (82%), Control: 0/54 (0%) * Follow-up rates were 81% and 78% in the treatment and control groups. Results provided for patients completing the trial.	OR = 471.27, P < 0.001
Hermiz., *et al.* [16]	Intervention aim: Improve care of COPD	Home visits by community nurses after hospital discharge vs usual GP care, Team change: Community nurses provided two home visits per patient. The first occurred within a week of a patient's discharge from hospital, and included a health assessment, COPD education, problem identification and disease management advice. Nurses worked with patients to develop care plans documenting problem areas, education provided, and referral to other services. Care plans were mailed to each patient's GP. At the second visit, one month later, nurses reviewed patients' progress and need for further follow-up.	Not clear	Follow-up period: 3 months	Group 1: 42/67 (63%), Control: 42/80 (53%)	OR = 1.52, P = 0.28

Apkon., *et al.* [17]	Improve preventive care, improve care of chronic diseases	Clinician reminders: The Department of Defense Problem-Knowledge Couplers is a computerized decision support system. Couplers uses structured questions based on the patient's chief complaint to elicit information from patients and providers. Patients were allocated 30 minutes to input their medical histories into the Coupler tool. Based on a proprietary database of medical knowledge, suggestions for patient care strategies are produced.	Not clear	Follow-up period: 60 days	Group 1: 1/61 (2%), Control: 0/72 (0%)	OR = 0.00*, P < 0.001*
Berg., *et al.* [18]	Intervention aim: Improve heart failure care	Patient education / reminders: A disease management plan was implemented, including formal scheduled nurse education sessions; 24 hour access to a nurse counseling and symptom advice telephone line; printed action plans, workbooks, and individualized assessment letters; medication compliance reminders; and vaccination reminders .Clinician reminders: Physicians were provided with reminders about treatment gaps and alerts for disease decompensation. Team change: A disease management nurse called patients regularly and facilitated information relay between the disease management program and each patient's physicians.	Group 1: 3%, Control: 2%	Follow-up period: 5 months	Group 1: 15%, Control: 9%	OR = 1.78*, P = 0.014**
Fishbein., *et al.* [19]	Intervention aim: Improve vaccination rates	Patient self-assessment / provider reminder tool vs usual care Facillitated relay of patient information: Patient completed a paper-based self assessment/ provider reminder (A/R) tool. The tool is comprised of a series of yes/no questions that assess patients' needs for 8 immunizations (reduced to 6 at two of three study sites). Clinician reminders: The A/R tool prompted clinicians to provide recommended vaccinations. The A/R tool also remained part of the patient chart after the initial visit at which it was produced. Patient education: The A/R tool was accompanied by educational material concerning recommended vaccinations.	Group 1: 45/105 (43%), Control: 53/112 (47%)		Follow-up – Vaccination during the day the A/R tool was provided**, Group 1: 23/60 (38%), Control: 8/59 (14%) - Group 1: 5/37 (14%), Control: 7/51 (14%)	- Follow-up – Vaccination during the day the A/R tool was provided**, OR = 3.96, P = 0.00 - Follow-up – 1 year after the A/R tool was provided**, OR – 0.98, P = 1.00
Winston., *et al.* [20]	Intervention aim: Improve vaccination rates	Patient education / reminders: Nurses telephoned eligible patients, inquired about previous pneumococcal vaccination and vaccination beliefs, and explained the vaccination. QI agent: Managed Care Organization Team change: Nurses trained in pneumococcal vaccine indications and contraindications called eligible patients.	Not clear	Follow-up period: 6 months	Chronic disease patients, Group 1: 288/1845 (16%) , Control: 111/1866 (6%), Elderly patients, Group 1: 201/1198 (17%), Control: 100/1197 (8%)	Chronic disease patients, OR = 2.21, P <0.001, Elderly patients, OR = 2.92, P <0.001

Harari., *et al.* [21]	Intervention aim: Improve preventive care	Comprehensive patient health risk survey leading to computer generated patient and GP feedback vs usual care. Patient education / reminders: Patients were mailed a questionnaire (HRA-O) comprised of sections on health behavior, preventive care uptake, and self-reported health. Facilitated relay of clinical information: Information from the patient questionnaire was forwarded to GPs, who selected relevant data elements for entry into the patient's	Not clear	Follow-up period: 1 year	Group 1: 308/939 (33%), Control: 291/1066 (28%)	OR = 1.2, P = 0.04
Lennox., *et al.* [22]	Intervention aim: Improve preventive care	Group 1: Comprehensive health assessment tool Group 2: Health advocacy tool Group 3: Comprehensive health assessment tool and health advocacy tool	Group 1: 4/53 (8%) Group 2: 2/51 (4%) Group 3: 18/70 (26%) Control: 7/68 (10%)	1 year	Group 1: 6/53 (11%) Group 2: 2/51 (4%) Group 3: 8/70 (11%) Control: 0/68 (0%)	Group 1 vs control, OR = 17.36, p = 0.006 Group 2 vs control, OR = 5.55, p = 0.18 Group 3 vs control, OR = 17.55, p = 0.004

Table 2: *Summary of interventions, results and outcomes.*

Discussion

We reviewed the different quality improvement interventions approaches for improving pneumococcal vaccination rates and their effectiveness. Most interventions were associated with relatively moderate improvements in vaccination rates.

Clinician reminders, Team change and patient outreach were effective for pneumococcal vaccinations. We found that interventions involving team change were effective, especially where nurses had been assigned responsibilities for administering vaccine. Recruiting or assigning an additional personnel in order to enable the relief of physicians of vaccinations seems important to successful team change [11]. Moreover, patient outreach may better increase vaccinations to the extent that direct personal contact is achieved.

Clinician reminders and education were associated with great improvements for pneumococcal vaccinations. A previous review has similarly reported that reminders involving person-to-person telephone contact were most effective [8].

Limitation of the Study

1. The present review did not address the economic value of the interventions.
2. Nonelderly adults or adults not in a physician's care, for whom vaccination recommendations have recently been expanded [23] were not part of the study
3. There was a publication bias- suggested by the funnel plot- which may have led our pooled odds ratios to be overly optimistic.
4. Meta-analysis approach was highly inclusive with 2 major limitations:

1. Lack of blinding may be relatively unimportant for quality improvement interventions designed to act, in part, by increasing awareness of vaccinations and for outcomes that can be measured relatively objectively by reviewing charts or billing data. Only 60% of studies reported and accounted adequately for potential confounders, however. This proportion was higher in randomized than in observational studies. However, we reported odds ratios pooled from all studies. The inclusion of a wide range of studies allowed us to produce quantitative summaries for many intervention categories. In particular, interventions requiring policy support or action

on a community scale, such as audit and feedback and community media campaigns, are difficult to randomize-observational studies comprise an important source of insight [24].

2. Heterogeneity of the pooled analysis which we were not able to detect due by lack of evidence.40 For example, reasons for decreases in the effectiveness of clinician reminders in recent years are unknown. We have incorporated heterogeneity into our meta-analysis by using a random-effects approach. Users should interpret pooled odds ratios as estimates of the average intervention effect, as opposed to a single, true effect. Our 95% confidence limits may provide bounds on the expected performance of the intervention under most circumstances. In any event, a single true effect would not likely be useful, because most users can identify mitigating or potentiating factors unique to their circumstances.

Thus, our estimates provide a preliminary basis for selecting interventions; potential users should examine our summaries of individual studies and intervention-specific forest plots) in light of their own circumstances and a theoretical understanding of behavior change [25].

Conclusion

Our results suggest that (1) shifting vaccine administration from physicians to members of the primary care team with clear responsibilities for chronic and preventive care and (2) activating patients through personal outreach may stand the best chance of improving vaccination rates in community dwelling adults. Nonetheless, practitioners and policy makers should temper their expectations of quality improvement interventions. In few treatment arms had vaccination rates improved sufficiently to meet national policy targets. Future research is required to develop and evaluate more potent approaches and to better understand how and why they work.

Bibliography

1. World Health Organization. “Estimated Hib and pneumococcal deaths for children under 5 years of age, 2008” (2012).

2. Drijkoningen JJ and Rohde GG. “Pneumococcal infection in adults: burden of disease”. *Clinical Microbiology and Infection* 20.5 (2014): 45-51.

3. Fedson DS and Chiarello LA. “Previous hospital care and pneumococcal bacteremia. Importance for pneumococcal immunization”. *Archives of Internal Medicine* 143.5 (1983): 885-889.

4. Musher DM and Bartlett JG. “Pneumococcal vaccination in adults”. Up-to-date (www. uptodate. com) (2013).

5. “Advisory Committee on Immunization Practices Prevention and control of seasonal influenza with vaccines: Recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009”. *Morbidity and Mortality Weekly Report* 58.RR-8 (2009): 1-52.

6. Euler GL., *et al*. “Influenza vaccination coverage among children and adults—United States, 2008-09 influenza season”. *Journal of the American Medical Association* 302.19 (2009): 2085-2086.

7. Brull R., *et al*. “Missed opportunities for prevention in general internal medicine”. *Canadian Medical Association Journal* 160.8 (1999): 1137-1140.

8. Jacobson VJ and Szilagyi P. “Patient reminder and patient recall systems to improve immunization rates”. *Cochrane Database of Systematic Reviews* 3 (2005): CD003941.

9. Guide to Community Preventive Services. Vaccinations to prevent diseases: targeted vaccinations. Community Guide to Preventive Services (2010): 1-2.

10. Dexter PR., *et al*. “A computerized reminder system to increase the use of preventive care for hospitalized patients”. *New England Journal of Medicine* 345.13 (2001): 965-970.

11. Stone EG., *et al*. "Interventions that increase use of adult immunization and cancer screening services: a meta-analysis". *Annals of Internal Medicine* 136.9 (2002): 641-651.
12. Thomas RE., *et al*. "Systematic review of interventions to increase influenza vaccination rates of those 60 years and older". *Vaccine* 28.7 (2010): 1684-1701.
13. Moher D., *et al*. "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement". *PLoS Medicine* 6.7 (2009): e1000097.
14. Beck A., *et al*. "Randomized trial of group outpatient visits for chronically ill older HMO members: The cooperative health care clinic". *Journal of the American Geriatrics Society* 45.5 (1997): 543-549.
15. Dalby DM., *et al*. "Effect of preventive home visits by a nurse on the outcomes of frail elderly people in the community: A randomized controlled trial". *Canadian Medical Association Journal* 162.4 (2000): 497-500.
16. Hermiz O., *et al*. "Randomised controlled trial of home based care of patients with chronic obstructive pulmonary disease". *British Medical Journal* 325.7370 (2002): 938.
17. Apkon M., *et al*. "A randomized outpatient trial of a decision-support information technology tool". *Archives of Internal Medicine* 165.20 (2005): 2388-2394.
18. Berg GD., *et al*. "A matched-cohort study of health services utilization outcomes for a heart failure disease management program". *Disease Management* 8.1 (2005): 35-41.
19. Fishbein DB., *et al*. "A comprehensive patient assessment and physician reminder tool for adult immunization: Effect on vaccine administration". *Vaccine* 24.18 (2006): 3971-3983.
20. Winston CA., *et al*. "Increasing pneumococcal vaccination in managed care through telephone outreach". *American Journal of Managed Care* 13.10 (2007): 581-588.
21. Harari D., *et al*. "Promotion of health in older people". *Age and Ageing* 37.5 (2008): 565-571.
22. Lennox N., *et al*. "Cluster randomized-controlled trial of interventions to improve health for adults with intellectual disability who live in private dwellings". *Journal of Applied Research in Intellectual Disabilities* 23.4 (2010): 303-311.
23. Advisory Committee on Immunization Practices. "Prevention and control of influenza with vaccines". *Morbidity and Mortality Weekly Report* 59.RR8 (2010): 1-62.
24. Norris SL and Atkins D. "Challenges in using nonrandomized studies in systematic reviews of treatment interventions". *Annals of Internal Medicine* 142 (2005): 1112-1119.
25. Looijmans-van den Akker I., *et al*. "How to develop a program to increase influenza vaccine uptake among workers in health care settings?" *Implementation Science* 6 (2011): 47.

Volume 9 Issue 3 July 2017