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Impact of pharmacists as immunizers on vaccination rates: a systematic review and meta-analysis

JE Isenor[a,b,c*], NT Edwards[a], TA Alia[a], KL Slayter[b,c], DM MacDougall[b,d], SA McNeil[b,c,e], SK Bowles[a,b,c,f,g]

[a]College of Pharmacy, 5968 College St, PO Box 15000, Dalhousie University, Halifax, Nova Scotia, B3H 4R2, Canada
[b]Canadian Center for Vaccinology, 5850/5980 University Ave, IWK Health Centre, Halifax, Nova Scotia, B3K 6R8, Canada
[c]Faculty of Medicine, 1459 Oxford St, Dalhousie University, Halifax, Nova Scotia, B3H 4R2, Canada
[d]School of Nursing, 1 West Street, St. Francis Xavier University, Antigonish, Nova Scotia, B2G 2W5, Canada
[e]Department of Medicine, 1276 South Park St, Queen Elizabeth II Health Sciences Centre, Halifax, Nova Scotia, B3H 2Y9, Canada
[f]Department of Pharmacy, 1796 Summer St, Queen Elizabeth II Health Sciences Centre, Halifax, Nova Scotia, B3H 3A6, Canada
[g]Centre for Health Care for the Elderly, 5955 Veterans Memorial Lane, Queen Elizabeth II Health Sciences Centre, Halifax, Nova Scotia, B3H 2E1, Canada

*Correspondence
Dr. Jennifer Isenor
College of Pharmacy, Dalhousie University
5968 College Street, PO Box 15000
Halifax, NS, Canada
B3H 4R2
Email: Jennifer.Isenor@Dal.ca

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ABSTRACT

Background: Underutilization of vaccination programs remains a significant public health concern. Pharmacists serve as educators, facilitators, and in some jurisdictions, as administrators of vaccines. Though pharmacists have been involved with immunizations in various ways for many years, there has yet to be a systematic review assessing the impact of pharmacists as immunizers in these three roles.

Objective: To complete a systematic review of the literature on the impact of pharmacists as educators, facilitators, and administrators of vaccines on immunization rates.

Methods: We identified 2825 articles searching the following databases from inception until October 2015: PubMed, EMBASE, Cochrane Libraries, Cumulative Index to Nursing and Allied Health Literature, International Pharmaceutical Abstracts, Google Scholar. Grey literature was identified through use of the Canadian Agency for Drugs and Technology in Health "Grey Matters" search tool. Content from relevant journals and references of included studies were also searched. Inclusion criteria were clinical or epidemiologic studies in which pharmacists were involved in the immunization process. Studies were excluded if no comparator was reported. Two reviewers independently completed data extraction and bias assessments using standardized forms.

Results: Thirty-six studies were included in the review, 22 assessed the role of pharmacists as educators and/or facilitators and 14 assessed their role as administrators of vaccines. All studies reviewed found an increase in vaccine coverage when pharmacists were involved in the immunization process, regardless of role (educator, facilitator, administrator) or vaccine administered (e.g., influenza, pneumococcal), when compared to vaccine provision by traditional providers without pharmacist involvement. Limitations of the results include the large number of non-randomized trials and the heterogeneity between study designs.

Conclusions: Pharmacist involvement in immunization, whether as educators, facilitators, or administrators of vaccines, resulted in increased uptake of immunizations.

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Keywords: Immunizer; Pharmacist; Vaccination

Introduction

Vaccinations are estimated to prevent between two and three million deaths each year and have been shown to be one of the most cost-effective health investments. [1] Despite this, underutilization of vaccination programs remains a significant public health concern, hindering the impact of vaccinations on reducing the burden for vaccine-preventable diseases and their complications. [2, 3] Consequently, vaccine-preventable diseases continue to be a significant source of morbidity and mortality, and consume considerable healthcare resources worldwide. [4].

Vaccines have been traditionally delivered via three venues: (a) physicians in their clinics or primary care offices, (b) public health systems in a number of settings, such as community health clinics or schools, and (c) in hospitals. [5, 6] While these routes are effective at capturing many high risk patients (children, elderly, and patients with chronic conditions), hard-to-reach populations are often missed. [7] Additionally, many factors have been identified as contributors to low vaccination rates, including general public apathy, concerns and misconceptions about the safety and efficacy of vaccines, cost, distance to clinics, inconvenient hours, and wait times. [8] In order to improve vaccine utilization, the major barriers to receiving vaccines must be addressed.

Among the strategies suggested to address these barriers and improve vaccination rates is the training of non-traditional vaccination providers to administer vaccines safely and effectively in their practice setting. [9] Pharmacists have been involved in the vaccination process as early as the mid-1800s through delivery of the smallpox vaccine to physicians and they continue to play an important role in the distribution of vaccines. [10,11] Pharmacists remain one of the most respected and accessible groups of healthcare providers, strategically dispersed throughout the healthcare system with practice sites including inpatient, ambulatory clinics, nursing care facilities, and community pharmacies. [12] Given the accessibility of pharmacists, they are a logical choice for expansion of vaccination delivery by non-traditional vaccination providers. [13] Whether providing information and recommendations on vaccines ("educator"), hosting traditional immunization providers, such as nurses, in the pharmacy to facilitate the access to vaccines ("facilitator"), or serving as an immunizer ("administrator"), pharmacists have an established role in vaccination delivery and contribute towards achieving the immunization goals of public health. [10, 14]

While pharmacists have functioned as immunizers in some countries (Canada, Ireland, Portugal, United Kingdom [UK], and the United States [US]), many countries have yet to expand the scope of pharmacy practice to include administration of vaccines. [15] If decisions are to be made on changing current practice, evidence to support such change is needed. While some studies have shown positive outcomes when pharmacists are involved with vaccinations, a comprehensive review of the literature may provide critical data to inform policy development and statutory reform to guide the expanding scope of pharmacy practice. [10]

The aim of this paper is to systematically review the literature to determine the impact of pharmacists as educators, facilitators, and administrators of vaccines on immunization outcomes (vaccination rates, vaccine-preventable morbidity and mortality, and safety).

Methods

The protocol is registered with the PROSPERO International prospective register of systematic reviews (http://www.crd.york.ac.uk/PROSPERO), registration number: CRD42013005067.

Search strategy

A comprehensive literature search was conducted to identify all relevant studies investigating immunization outcomes in the general population when pharmacists are involved with the vaccination process in addition to traditional providers. The following databases were searched: PubMed, EMBASE, Cochrane Libraries, Cumulative Index to Nursing and Allied Health Literature (CINAHL), International Pharmaceutical Abstracts (IPA), and Google Scholar from inception to October 2015 with no date or language restrictions. Key search terms included: "Vaccination" and "Pharmacist" along with keywords "immuni*", "vaccin*", or "shot" in combination with "pharmacist*". Grey literature was identified through use of the Canadian Agency for Drugs and Technology in Health (CADTH) "Grey Matters" search tool, searching OpenSIGLE, NY Academy of Medicine Grey Literature Report, Biological Abstracts, National Technical Information Services (NTIS), Proquest, WorldCat, NLM Gateway, and ABI Inform, as well as searching the table of contents of relevant journals. Additional studies were screened through Web of Science and manual reference review of relevant studies.

Study Selection

Three reviewers (SB, NE, JI) independently screened titles and abstracts for inclusion. Full articles were then reviewed using relevance assessment forms with inclusion and exclusion criteria determined *a priori*.

Inclusion criteria were:

(1) study involved only humans;

(2) clinical trial or epidemiologic study;

(3) impact of pharmacists was evaluated; and

(4) measured immunization outcomes of interest (such as vaccine coverage, vaccine-preventable morbidity and mortality, and safety).

Exclusion criteria were:

(1) No comparator reported.

The reviewers met and came to consensus on all studies included.

Data Extraction and Study Appraisal

Data were independently extracted by two reviewers (NE and AP) using a standardized collection form that was piloted using 5 studies. Study parameters, design, methodology, and results were extracted from the articles. If information of interest was not available in the main text, supplementary data were searched and authors were contacted for further information. The level of pharmacist intervention was classified using the previously defined categories of "educator", "facilitator", or "administrator". [14]

Risk of Bias Assessment

Bias assessment was completed independently by two reviewers (NE and AP) using a modified version of the Agency for Healthcare Research and Quality (AHRQ) Assessing

Risk of Bias and Confounding in Observational Studies of Interventions or Exposures framework. Studies were categorized as high, low or unclear risk of bias as outlined in the Cochrane Collaboration's Tool for Assessing Risk of Bias. [16, 17]

Meta-analysis

Statistical analyses and summary of the data from randomized, controlled trials was performed using Comprehensive Meta-Analysis software, version 3 and Review Manager 5 (RevMan 2012). Dichotomous outcomes were presented as risk ratios (RR) with corresponding 95% confidence intervals (CI). An intention to treat (ITT) analysis of outcomes from all randomized participants was used for primary analyses. The unit of analysis was the individual patient. Forest plots were used to visually assess statistical heterogeneity of studies and Chi square was used to assess evidence of heterogeneity ($p<0.01$). [18] The I^2 statistic was also calculated with I^2 values greater than 50% indicating substantial to considerable heterogeneity. [19]

The random-effects method based on the inverse variance method was used to pool data based on the assumption that effects estimated from each different study are not identical but followed the same distribution. [19, 20] Summary intervention estimates are a weighted mean of the estimate from each individual study. A fixed-effect model was considered as a sensitivity analysis.

Clinically relevant subgroup analyses and univariate meta-regression were performed using restricted maximum-likelihood to estimate the between study variance. The potential sources of variability explored were type of vaccine (influenza, pneumococcal, and herpes zoster), study type (educator vs. administrator) and mean age of participants. Sensitivity analysis was performed to evaluate the decision to include studies solely consisting of hospital in-patients.

Results

Search Results

Out of a potential 2,825 publications, thirty-six papers met the inclusion criteria. (Figure 1). [21-56] Six randomized controlled trials were identified and included in the meta-analysis.

Characteristics of Included Studies

Twenty-two of the included studies assessed the role of pharmacists as educators and/or facilitators (Table 1), and 14 assessed their role as administrators of vaccines (Table 2). Twenty-seven of the studies were non-randomized, three were cluster randomized trials, and six were randomized controlled trials. Thirty-five studies were found to have a high risk of bias and one had an unclear risk (Tables 1 and 2).

Pharmacist interventions were diverse between studies, with strategies including one-on-one patient education, patient mail outs, phone calls, and advertising in the media. Although studies evaluated the provision of a variety of vaccines by pharmacists, including tetanus and herpes zoster, the majority of studies evaluated the provision of influenza and/or pneumococcal vaccines.

All studies reviewed demonstrated an increase in vaccine coverage when pharmacists were involved in the immunization process, regardless of role (educator, facilitator, administrator) or vaccine administered (e.g., influenza, pneumococcal), when compared to vaccine provision by traditional providers without pharmacist involvement. Four of the studies noted that no adverse effects were noted with pharmacist involvement in immunization. [32, 38, 44, 45] One study evaluated vaccine-preventable disease activity. [22]

Summary of Studies Evaluating Pharmacists as Educators and Facilitators

The categories of educator and facilitator were merged as these interventions were frequently combined within a single study. Of the 22 studies identified, six were randomized or cluster randomized trials [21-26] and 16 were non-randomized trials [27-42] (Table 1). Of the 22 studies, 21 were identified as having a high risk of bias primarily due to lack of randomization. [21-23, 25-42] One of the randomized controlled trials had an unclear risk of bias [24], as there was insufficient information available for complete assessment despite contacting the author. Outcomes evaluated included vaccine uptake and vaccine efficacy. All 22 studies found an increase in vaccination rates/vaccine coverage in the pharmacist intervention groups [21-42]. One randomized controlled trial demonstrated a decreased risk of self-reported influenza-like illness (RR 0.18, 95% CI, 0.004 to 0.83). [22] Two studies evaluating pharmacists as educators found no reports of adverse effects with vaccination. [32, 38]

Meta-analysis of Studies Evaluating Pharmacists as Educators and Facilitators

Pooled analysis of data for pharmacists as educator/facilitator (Figure 2) demonstrated a significant improvement in the number of individuals immunized (RR 2.96, 95% CI 1.02, 8.59), favouring the intervention. High heterogeneity ($p<0.00001$, $I^2 = 90\%$) was observed in this analysis, attributed to inclusion of a study involving hospital in-patients ([40] Dumo P), whereas the remainder of studies were community based.

Summary of Studies Evaluating Pharmacists as Administrators

A total of 14 studies were identified which evaluated pharmacists administering vaccines as the intervention (Table 2). [43-56] Of these, two were randomized controlled trials [52, 55], one was a cluster randomized trial [46] and 11 were non-randomized trials. [43-45, 47-51, 53-54, 56] All of the studies were identified as having a high risk of bias, primarily due to non-randomized design and lack of assessor blinding. All 14 studies found an increase in vaccination rates/vaccine coverage in the pharmacist intervention groups [43-56]. Vaccine-preventable morbidity and mortality were not addressed in any of the studies. Two studies that included safety in their evaluation found no reports of adverse effects with vaccinations administered by pharmacists [44, 45].

Meta-analysis of Studies Evaluating Pharmacists as Administrators

Pooled analysis of two randomized controlled trials (Figure 2) demonstrated a significant increase in the primary outcome of interest, increased immunization rates, in favour of pharmacists as vaccine administrators (RR 2.64, 95% CI 1.81, 3.86). Both studies [52, 55] included different interventions in different groups with separate control groups; therefore each subgroup was treated separately in the pooled analysis (Otsuka nPHR, Otsuka PHR, and Higginbotham P2 and Higginbotham P3). The test for heterogeneity was not significant ($p=0.95$, $I^2 = 0\%$).

Meta-Analysis of Studies Evaluating Pharmacists as Educators, Facilitators, and Administrators

Pooled analysis of the six randomized controlled trials (Figure 2) demonstrated a significant increase in the primary outcome of interest, increased immunization rates, in favour of pharmacists as immunizers (RR 2.74, 95% CI 1.58, 4.74). [23,24,40,43,52,55] High heterogeneity ($p<0.00001$, $I^2 = 90\%$) was observed in this analysis, attributed to inclusion of a study involving hospital in-patients ([40] Dumo P), whereas the remainder of studies were community based. The removal of the Dumo paper resulted in statistically significant results (RR 2.106, 95% CI 1.629 to 2.723) that continued to favour the addition of pharmacists as immunizers and showed no evidence of heterogeneity ($p=0.781$, $I^2 = 0\%$)

Discussion

This systematic review and meta-analysis demonstrates the impact of pharmacists in immunization activities, regardless of their role or vaccine provided. All 36 studies included in the review demonstrated an increase in vaccinations provided with the addition of pharmacists in all roles evaluated (educator, facilitator, or administrator).

Improvements in immunization rates by pharmacists can be attributed to a variety of factors. Pharmacists are trusted health care professionals. [57] Recommendations for immunizations from a pharmacist have been shown to increase immunization rates similar to those made by physicians or nurses. [21] Convenience and accessibility have been identified as important facilitators of immunization acceptance by patients, making it likely that extended hours of operation (evenings and weekends) and walk-in availability contribute to increased vaccine uptake in pharmacies. [58-63] Accessibility of pharmacists in medically underserviced areas has also been shown to improve immunization rates. [64] In urban settings, challenges such as parking may interfere with visits to primary care clinics. [61, 62] Another potential benefit is the avoidance of encountering acutely infectious individuals in clinic waiting rooms when seeking preventative health measures. [62]

The positive impact of pharmacists as immunizers suggests benefit in expanding the scope of pharmacist practice to include administration of vaccines. The addition of pharmacists as administrators could help to improve vaccination rates among hard-to-reach populations, such as young adults with no primary care physician. [7] While concerns have been raised about the shifting of vaccine administration from physicians to pharmacists, studies from the United States support an overall increase in vaccination rates when pharmacists administer vaccines. [43, 47]

Studies of pharmacists' impact on immunization rates are primarily related to influenza and pneumococcal vaccines. Although this research was unable to identify changes in vaccine-preventable disease-related morbidity and mortality, improving immunization rates is known to reduce the burden of vaccine-preventable diseases in adults. [65-67]

The administration of other vaccines (including pertussis and herpes zoster) by pharmacists is not as well studied; however, our review did include several studies that examined coverage for these vaccines. Although not universally funded in many jurisdictions, programs aimed at vaccinating postpartum mothers and other family members of newborn infants to protect infants from pertussis, known as cocooning programs, have been shown to decrease the burden of pertussis in newborns. [68, 69] The involvement of pharmacists in cocooning programs has been shown to improve immunization coverage rates among caregivers and close contacts of newborns, thereby enhancing protection of infants until they have completed their primary immunization series. [54]

Strengths of this review include the comprehensive search strategy, which included extensive searches of the grey literature, and the use of three independent reviewers to assess study inclusion.

There are several limitations to this review. First, due to very few trials assessing vaccine-preventable morbidity and mortality and safety, we were unable to review these outcomes in significant detail. However, the large number of studies included all showed an increase in vaccination rates, which would be expected to result in a decrease in the burden of vaccine-preventable disease. [70-72] Second, there was a limited number of randomized controlled studies and subsequently the studies included were assessed to have a high risk of bias. Despite this limitation, there were many studies of acceptable quality and size, given the nature of the intervention of interest, which showed evidence to support the increase in vaccination coverage obtained with the addition of pharmacists as immunizers, and six randomized controlled trials with sufficient data to complete a meta-analysis (RR 2.74, 95% CI 1.58, 4.74). [23,24,40,43,52,55] Another limitation was the heterogeneity of study interventions. Regardless of the differing interventions and methods, the studies all found an increase in vaccination coverage with the addition of pharmacists as immunizers. Despite the limitations of the literature reviewed, the consistency of findings from the large number of studies, as well as further support from a recent small meta-analysis, which found similar results, provides evidence to support the addition of pharmacists as immunizers. [73]

Conclusions

There is evidence in the literature that the involvement of pharmacists in immunization, whether as educators, facilitators, or administrators of vaccines, results in increased immunization rates. High quality studies are required to accurately quantify the absolute benefit.

Disclosures

Author Contributions:

All authors had complete access to the study data, contributed to the design of the study, interpretation of the data, and critically revised the work for important intellectual content. All authors gave final approval of the version to be published and agree to be accountable for all aspects of the work.

Jennifer Isenor: Study design, study selection, study appraisal, interpretation of data, manuscript preparation

Nick Edwards: Literature search, study selection, data extraction, bias assessment, interpretation of data, manuscript preparation

Tania Alia: Data extraction, bias assessment, interpretation of data, manuscript preparation

Kathryn Slayter: Study design, interpretation of data, manuscript preparation

Susan Bowles: Study design, study selection, study appraisal, interpretation of data, manuscript preparation

Shelly McNeil: Interpretation of data, manuscript preparation

Donna MacDougall: Interpretation of data, manuscript preparation

Conflicts of Interest

JEI has received research funding from GSK, unrelated to the conduct of this study. SAM has received research funding from GSK, Pfizer, Novartis, Sanofi Pasteur, and Merck unrelated to the conduct of this study. DM has received research funding from GSK and Sanofi, unrelated to the conduct of this study.

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Figures and Tables:

Figure 1: Flow diagram for selection of studies

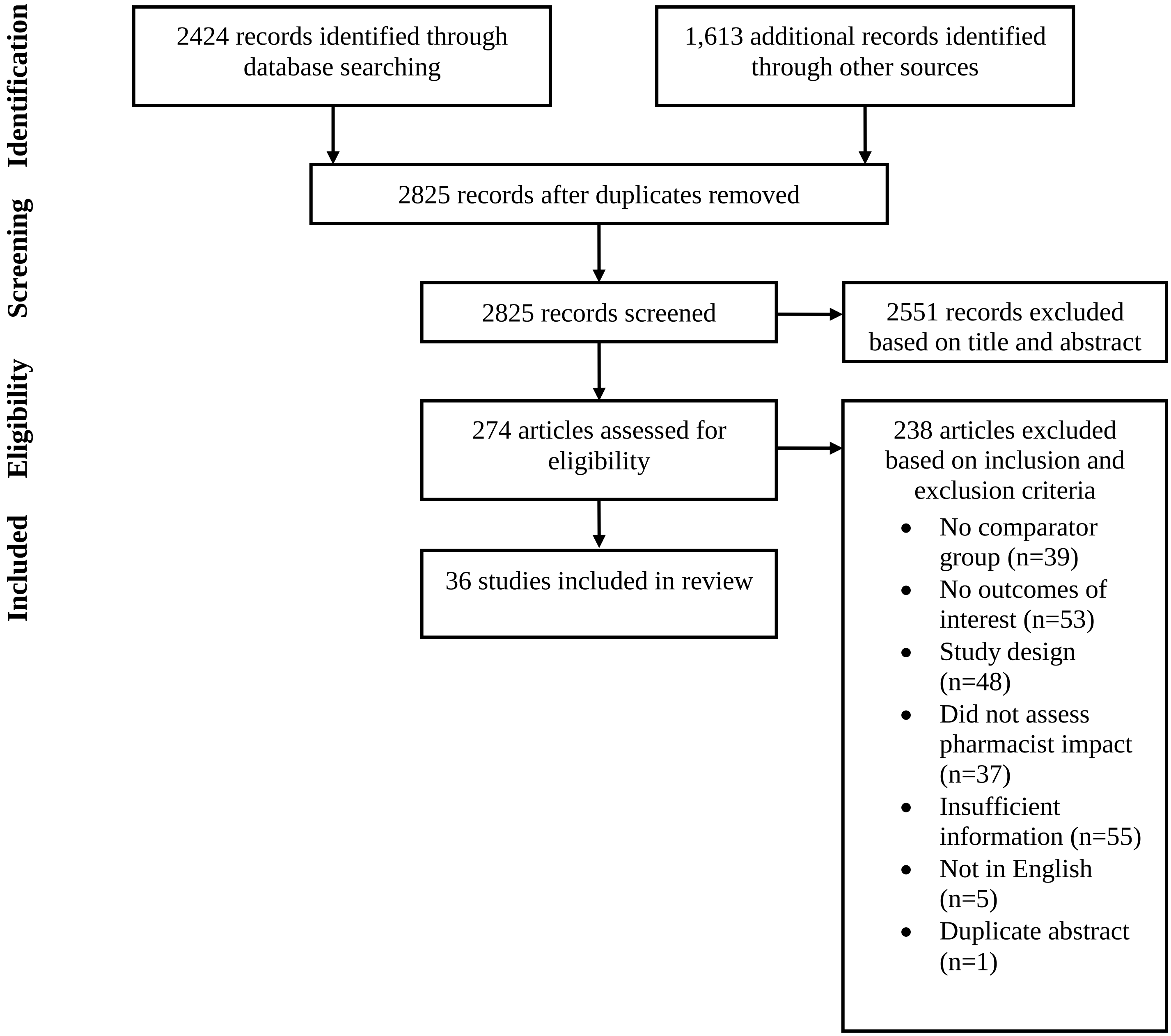
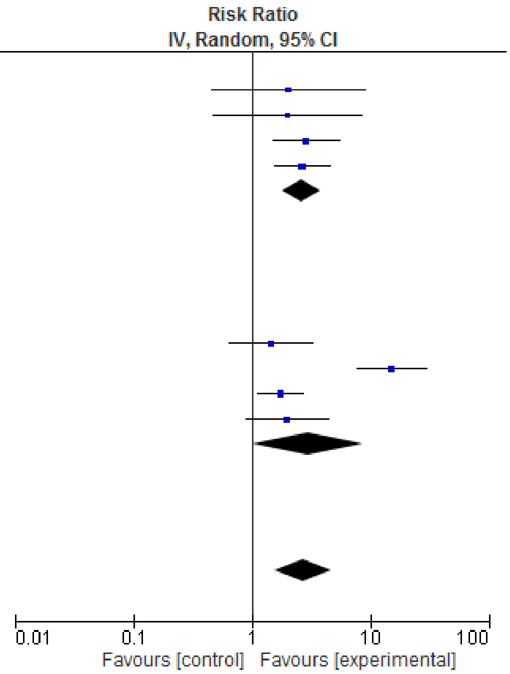


Figure 2: Forest Plot of Impact of Pharmacist Interventions by Pharmacist Activity - Administrator, Educator/Facilitator and Overall (Administrator + Educator/Facilitator)

	Intervention		Control			Risk Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**IV, Random, 95% CI**
1.2.1 Administrator						
Higginbotham P2	6	28	2	19	7.7%	2.04 [0.46, 9.04]
Higginbotham P3	8	36	2	18	7.9%	2.00 [0.47, 8.46]
Otsuka nPHR	13	250	30	1665	14.2%	2.89 [1.53, 5.46]
Otsuka PHR	33	250	21	424	15.1%	2.67 [1.58, 4.50]
Subtotal (95% CI)		**564**		**2126**	**44.9%**	**2.64 [1.81, 3.85]**
Total events	60		55			
Heterogeneity: Tau² = 0.00; Chi² = 0.34, df = 3 (P = 0.95); I² = 0%						
Test for overall effect: Z = 5.05 (P < 0.00001)						
1.2.2 Educator						
Cunningham	13	150	9	151	12.6%	1.45 [0.64, 3.30]
Dumo	126	155	8	148	13.8%	15.04 [7.63, 29.63]
Grabenstein	39	125	24	134	15.7%	1.74 [1.11, 2.72]
Rabi	15	64	8	68	12.9%	1.99 [0.91, 4.38]
Subtotal (95% CI)		**494**		**501**	**55.1%**	**2.96 [1.02, 8.59]**
Total events	193		49			
Heterogeneity: Tau² = 1.06; Chi² = 31.10, df = 3 (P < 0.00001); I² = 90%						
Test for overall effect: Z = 2.00 (P = 0.05)						
Total (95% CI)		**1058**		**2627**	**100.0%**	**2.74 [1.58, 4.74]**
Total events	253		104			
Heterogeneity: Tau² = 0.45; Chi² = 31.45, df = 7 (P < 0.0001); I² = 78%						
Test for overall effect: Z = 3.59 (P = 0.0003)						
Test for subgroup differences: Chi² = 0.04, df = 1 (P = 0.84), I² = 0%						



Note: Otsuka included two separate intervention groups, each with a separate control group

Table 1: Characteristics of Studies that Assessed Pharmacists as Immunization Educators and/or Facilitators

Study/Design/Duration	Participants	Interventions/ Role of the Pharmacist	Outcomes	Results	Bias Assessment	Other Comments
Influenza						
[26] Ellmers (2011) Quasi-experimental September 23-December 31, 2010	Patients with diabetes who had at least one diabetic medication filled at a community pharmacy (n=33)	Intervention group: Pharmacist counseling to educate patients about the importance of receiving annual influenza vaccines via telephone (n=12, 8 patients counseled) Control group: Pre-intervention	Number of patients vaccinated for influenza	Post-intervention: 25% (2/8 patients) vaccinated for influenza Pre-intervention (control): 58% (19/33 patients) vaccinated for influenza Total vaccinated by the end of the study: 67% (22/33 patients) vaccinated for influenza (19 pre-intervention, 2 post-intervention, 1 post follow up survey)	High risk of bias -Study design	

				2 patients did not receive vaccination due to contraindications		
[27] Fera (2008) Quasi-experimental January 2006 – September 30, 2007	Patients enrolled in a diabetes care program (n=914)	Intervention group: Diabetes certified pharmacists provided clinical assessments and progress toward diabetes clinical goals (n=914) Control group: Baseline levels prior to program enrollment	Vaccination rates for influenza	Percentage of patients with current influenza vaccination increased from 43% to 61%	High risk of bias -Study design	Unclear how they found the control data or how many people they looked at (but appears it was based on the same group of people and assessed how they changed)
[21] Grabenstein (1993) Randomized controlled trial Five months	Community pharmacy patients at high risk of influenza infection (n=482; 259 previously unvaccinated)	Intervention group: Patients were mailed a letter advising of infection risk and influenza vaccine availability (n=242; 125 unvaccinated prior to letter) Control group:	Number of patients vaccinated for influenza	<u>Unvaccinated prior to letter</u> Intervention: 39/125 (31.2%) Control: 24/134 (17.9%) Difference in rates: 13.3% (p=0.013) <u>Overall vaccine</u>	High risk of bias -No blinding of outcome assessor -Loss to follow up	

		Patients were mailed a control letter unrelated to influenza immunization (n=240;134 unvaccinated prior to letter)		acceptance rate (including those vaccinated before receiving letter) Intervention: 156/242 (64.5%) Control: 130/240 (54.2%) Difference in rates: 10.3% (p=0.021)		
[28] McCord (2006) Quasi-experimental October 2001 – June 2002	Patients aged 18 or older with diabetes mellitus referred to a clinical pharmacy service (n=316)	Intervention group: Diabetes education service including drug therapy management by a clinical pharmacist (n=96) Control group: Pre-intervention baseline data	Influenza vaccination rates	Preventative care assessment performed at both baseline and follow-up for 96 (30.4%) patients Intervention: 47% vaccinated against influenza Control: 36% vaccinated against influenza	High risk of bias -Study design	Pharmacist provided education in a collaborative care practice
[22] Usami (2009) Cluster Randomized Controlled Trial	Patients aged 65 and older receiving prescriptions	Intervention group: Pharmacists provided	Influenza vaccination rates	Intervention: 81.6% were vaccinated	High risk of bias -Recall bias (patient survey, self-reporting	Number of patients who had influenza was

October 14, 2003 – May 2004	at the participating community pharmacies (n=1863)	information on influenza risks, and the benefits of vaccination through posters and leaflets (n=911, 40 pharmacies) Control group: Pharmacists only discussed vaccinations upon patient inquiry (n=952, 44 pharmacies)		Control: 64.9% were vaccinated Vaccination rate following implementation of intervention was significantly higher than control (p<0.001) Vaccination rates prior to intervention were 61.3% in intervention and 53.3% in control	vaccination) -Outcome assessor not blinded	significantly lower in the intervention group (2/881) than in control group (11/895) (p=0.022) RR of having influenza in the intervention compared with control was 0.18 (95%CI=0.04-0.83) No patients with influenza-associated hospitalization were observed
[29] Van Amburgh (2001) Quasi-experimental 1999 flu season (October – December)	Community pharmacy patients at high risk of influenza infection (n=657)	Intervention group: Education packets regarding influenza immunization mailed by pharmacists to	Number of patients who received influenza vaccine	Intervention group (1999): 53.8% (354/657) of patients with indication were vaccinated 9% (148/657)	High risk of bias -Study design	Pharmacists organized and prepared vaccines at clinics, nurses administered vaccine

		patients. Vaccinations given at clinics and follow-up surveys conducted Comparator: Vaccination rates to program initiation		without indication were vaccinated Control group (1998): 28% (182 patients) with indication were vaccinated 6% (102 patients without indication vaccinated <u>By Age:</u> Age ≥65 with another indication: 44.6% to 70.9% ($p<0.05$) Age ≥65, no another indication: 37.9% to 41.9% ($p=0.527$) Age <65 with indication: 16.6% to 42.2% ($p<0.05$)			

				Age <65 with no indication: 3.9% to 6.4% (p<0.05)		
Pneumococcal						
[30] Carroll Noped (2001) Quasi-experimental October – November, 1999	Patients admitted to general medicine services	Intervention group: Patients meeting criteria for pneumococcal vaccine Pharmacists advocated vaccination with patient/family and MD (n=356) Control group: Vaccination rates of patients admitted and received pneumococcal vaccine prior to program implementation generated by computer	Number of patients who received the pneumococcal vaccine following pharmacist evaluation and intervention	Intervention: 134/458 patients were vaccinated Control: 26/354 vaccinated during the same period the year before 196/356 patients had never received the vaccine 134/196 eligible patients received the vaccine	High risk of bias -Study design	
[31] Coyle (2004) Quasi-experimental	Patients admitted to hospital 65 years or older	Co-intervention group: Pharmacists activated a	Vaccination rates for pneumococcal vaccine	Co- Intervention Standing Orders: 75% accepted vaccination	High risk of bias -Study design -Selection bias (no attempt to	

Four months in spring 1999	and had not received pneumococcal vaccination in the past 5 years (n=424)	standing order protocol for pneumococcal vaccination in eligible patients. (n=147, 56 eligible patients) Co-intervention group: Computerized reminders to physicians for pneumococcal vaccination in eligible patients. (n=122, 55 eligible patients) Control group: Patients on one ward were not screened by pharmacy staff (n=155)		Co-Intervention Computerized reminders: 64% accepted vaccination Control: 1 patient received vaccination	balance allocation or randomization between groups)	
[23] Cunningham (2010) Randomized controlled trial June 2003 – February	Patients seen at a diabetes care clinic who are 18 or older (n=1349)	Intervention group: Chart review conducted by pharmacists and recommendations made to primary	Number of patients receiving pneumococcal vaccination	Intervention: Baseline rate of 66% improved to follow up rate of 74.7% Control:	High risk of bias -No blinding of outcome assessor -Did not assess impact for loss to follow up (21 in intervention, 24	P values: P=0.361for baseline and p=0.186 for follow up

2010		care physicians (PCP) through letters at time of next PCP visit (n=171) Control group: Patients did not receive recommendation letters from the pharmacy team. (n=175)		Baseline rate of 60.9% improved to follow up rate of 66.9%	in control)	
[32] Dodds (2001) Quasi-experimental October 1999 – April 2000	Patients admitted to hospital at risk of pneumococcal infection who were screened to meet criteria for vaccination intervention (n=640)	Intervention group: Pharmacy students screened patients when admitted to hospital for pneumococcal unvaccinated, vaccine eligible patients. Students then made recommendation to medical team for an order to be written by physician (n=418)	Number of patients receiving pneumococcal vaccine following pharmacy screening	Intervention: 134/418 patients were vaccinated Control: 222/640 had previously been vaccinated Increased overall vaccination rate from 38% to 57%	High risk of bias -Study design	No significant adverse events were noted

		Control group: Pre-admission vaccination rates				
[33] Morton (1988) Quasi-experimental Duration not provided	Long term care facility patients (n=276)	Intervention group: Long term care physicians contacted by pharmacists regarding willingness to vaccinate patients which allowed pharmacists to complete vaccine order forms. Once forms were complete and signed by physician, nursing staff assessed current vaccination status of patients and vaccinated those who had no contraindications (n=172) Control group: Patients at	Number of patients vaccinated with pneumovax post intervention	Intervention: 5 patients were vaccinated pre-intervention (2.9%) and 144 were vaccinated post intervention (83.7%) Control: 1 patient in the control group was vaccinated pre-intervention (0.9%) and 4 were vaccinated post intervention (4%)	High risk of bias -Study design -Selection bias	

		another long term care facility that did not participate				
[34] Nyame-Mireku (2006) Quasi-experimental One month	Hospital admissions >65 years of age screened for pneumococcal vaccine status (n=50)	Intervention group: Pharmacists screened for patients who had vaccine ordered by physicians but had not been given the vaccine, then notified nurses of the order to ensure vaccinations were given (n=25) Control group: Patients screened for pneumococcal vaccine status prior to discharge. (n=25)	Number of patients who received the pneumococcal vaccine	Intervention: 23/25 (92%) patients vaccinated Control: 12/25 (48%) patients vaccinated The difference was statistically significant ($p<0.001$)	High risk of bias -Study design	
[24] Rabi (2006)	Admitted hospital	Intervention group:	Number of patients who	Intervention: 15/64 (23.4%)	Unclear risk of bias	

Randomized controlled trial March 1 – May 31, 2006	patients at risk for pneumococcal infection (n=150)	Vaccination history obtained by pharmacist for admitted patients to determine vaccine eligibility (n=75, 64 patients unvaccinated) Control group: Vaccination history obtained by nurse for admitted patients to determine vaccine eligibility (n=75, 68 patients unvaccinated)	received pneumococcal vaccination	patients vaccinated Control: 8/68 (11.7%) patients vaccinated The difference was significant (p=0.038)	-Not enough information to assess bias	
[35] True Robke (2002) Quasi-experimental October 1999 – March 31, 2000	Patients admitted to hospital with either of 4 diagnosis and placed on the appropriate critical pathway (community acquired pneumonia,	Intervention group: Patients placed on community-acquired pneumonia and hip fracture repair pathways received education from the pharmacist about the need	Number of patients who received the pneumococcal vaccine	Intervention: 60 patients (56.1%) previously vaccinated and 39 patients (36.4%) determined to need vaccination 19 patients (59.4%) were	High risk of bias -Study design	

	hip fracture, COPD, total hip replacement) (n=231)	for vaccination and pharmacist made recommendation to physician (n=107). Control group: Patients placed on the COPD and total hip replacement pathways were screened for risk factors but no education on vaccinations was provided (n=124).		vaccinated following intervention Overall vaccination rate improved from 60/107 to 79/107 Control: 58 (46.8%) previously vaccinated and 46 (37.1%) determined to need vaccination 0 patients were vaccinated vaccination rates remained at 58/124 Overall end vaccination rates: 73.8% in the intervention group and 46.8% in the control group (p<0.001)		
[36] Skledar (2003)	University	Intervention	Pneumococcal	Intervention:	High risk of bias	2 adverse

Quasi-experimental February 2000 – January 2002	hospital general medicine unit patients screened for pneumococcal vaccination risk (n=1967)	group: Pneumococcal risk assessed by pharmacists and vaccine ordered and administered for eligible patients (n=1967 screened, 1195 eligible for vaccination) Control group: Baseline data prior to program implementation. (n=312)	vaccination rates	≥65: Overall vaccination rate of 277/949 (29.2%) <65: Overall vaccination rate of 163/561 (29.1%) Total: 125/1195 (10.5%) patients vaccinated during the program for an overall vaccination rate of 440/1510 (29.1%) Control: 0/309 patients vaccinated Vaccination rates were significantly different from baseline ($p<0.0001$)	-Study design -Length of follow-up different between study groups -Selection bias (allocation based on admission date)	effects to vaccination; both local site reactions
[37] Skledar (2007)	Patients 65	Intervention	Vaccination	Intervention:	High risk of bias	Control:

Quasi-experimental 2005 – no duration specified	years of age and older & pneumonia admissions, admitted to a tertiary care hospital screened for vaccination status	group: Screening completed by pharmacy students or technicians to assess eligibility then appropriateness of pneumococcal vaccine assessed by pharmacist and administered by nurses Control group: Traditional physician-reminder pneumococcal vaccination program in which pharmacy personnel performed the patient risk assessment then placed preprinted order forms which required a physician signature in	rates for pneumococcal vaccine	Average vaccination rate of 70% for 2005, with a max of 89% in March 2005 Control: Prior chart reminder program reached 38% in 2003	-Study design	Vaccination rate of 31% in 2000, and 15% in 2003.

		patient's charts for those who were eligible.				
[38] Vondracek (1998) Quasi-experimental April 1-31, 1996 & May 1-June 11, 1996	Admitted cardiology and medical services patients (n=529, 447 charts reviewed)	Intervention group (phase 2): Chart review for patients eligible to receive pneumococcal vaccination and prior vaccination status, followed by reminders to physicians placed in patients charts of unvaccinated patients (n=249) Control group (phase 1): Chart review for patients eligible to receive pneumococcal vaccination and prior vaccination status (n=198)	Number of patients vaccinated with pneumococcal vaccine	Intervention: 80 patients were vaccine eligible 23/80 vaccine eligible patients received vaccination Control: 80 patients were eligible to receive pneumococcal vaccine 0/80 vaccine eligible patients received vaccination Significant increase in vaccination rate after intervention compared to control (p<0.001)	High risk of bias -Study design	No significant adverse reactions to vaccination were reported in patient charts
Combination						
[39] Bourdet (2003)	Patients over age 18	Intervention group:	Number of patients who	Intervention: 71% (66/93) of	High risk of bias -Study design	

Quasi-experimental January 2 – February 28, 2001	admitted to public teaching hospital (n=1303)	Screening conducted by pharmacists on general medicine, pulmonary medicine and infectious diseases units for influenza and pneumococcal vaccine eligible patients and standing orders for the vaccinations were written (n=542) Control group: Influenza and pneumococcal eligible patients admitted to renal and GI medicine, Cardiology and family medicine units were not targeted by pharmacists for vaccination (n=761)	received the influenza and/or pneumococcal vaccine	non-immunized eligible patients received the pneumococcal vaccination 55.3% (47/85) of non-immunized eligible patients were vaccine influenza vaccine Control: Less than 1% of all patients with indications received either vaccine Pneumococcal: 14.9% (66/442) of patients in intervention vaccinated compared to 0.5% (3/608) in control ($p<0.0001$) Influenza: 9.8% (47/478) of patients in	-No attempt to balance allocation between groups	

				intervention vaccinated compared 0.8% (5/659) in control (p<0.001)		
[40] Dumo (2002) Randomized, controlled trial November 2001 – March 2002	Admitted medicine, infectious disease or surgery patients at a university hospital (n=536)	Intervention group: Pharmacists screened for pneumococcal and influenza vaccination eligibility and made recommendations Control group: Usual care by physician	Number of patients vaccinated for pneumococcal and influenza	Intervention: 125/151 eligible patients received influenza vaccine 126/155 eligible patients received pneumococcal vaccine Control: 8/148 eligible patients received influenza vaccine 7/158 eligible patients received pneumococcal vaccine Influenza: Rates of influenza vaccination increased from 5% (8/148) in control group to 83% (125/151)	High risk of bias -Study design -Allocation by admission date	Influenza and pneumococcal vaccine rates increased in all groups (p<0.05) except for influenza in the surgery group

				in the intervention group (p<0.01) Pneumococcal: Rates of pneumococcal vaccination increased from 5% (7/158) in control group to 82% (126/155) in the intervention group (p<0.01)		
[25] Ginson (2000) Cluster randomized controlled trial October 20 – November 21, 1997	Patients admitted to family practice program (n=102)	Intervention group: Written and verbal information about influenza and pneumococcal vaccines provided by pharmacists to patients and patients offered the opportunity to be vaccinated in hospital (n=50)	Number of patients vaccinated with the influenza and/or pneumococcal vaccine	Intervention: 61% (17/28) received influenza vaccine 67% (33/49) received pneumococcal vaccine Control: 16% (6/37) received influenza vaccine 21% (10/48) received	High risk of bias -Outcome assessor not blinded -Physicians limited to 1 group or the other, so based on their daily practice all their patients could have similar recommendations for vaccines	

		Control group: Usual care (n=52)		pneumococcal vaccine Both differences were statistically significant (p=0.0001)		
[41] Padiyara (2011) Quasi- experimental January 1 – December 31, 2007	Diabetes care patients at least 18 years or older (n=642)	Intervention group: Pharmacist education and management of drug therapy and preventative care services for diabetic patients. (n=321) Control group: No interaction with the pharmacist-managed diabetes clinic (PCP usual care group) (n=321)	Number of patients vaccinated for pneumococcal and influenza	Influenza vaccine: < 65 years: Rates increased from 27.7% (44/159) in control group to 44.9% (83/185) in intervention group (p=0.001) ≥ 65 years: Rates increased from 66.7% (108/162) in control to 72.8% (99/136) in intervention group (p=0.501) Pneumococcal vaccine: < 65 years: Rates increased from 23.9% (38/159) in control group	High risk of bias -Study design -No baseline values	

				to 38.9% (72/185) in intervention group (p<0.001) ≥ 65 years: Rates increased from 45.7% (74/162) in control to 72.8% (99/136) in intervention group (p<0.001)		
[42] Wallgren (2012) Quasi-experimental September 15, 2008 – March 15, 2011	Diabetic patients seen in a military medical treatment facility (n=188)	Intervention group: Medication management and diabetes education provided by a pharmacist (n=98) Control group: Primary care provider managed diabetes (n=90)	Rate of pneumococcal and influenza vaccination	Intervention: 78.6% of patients had documentation of receiving the influenza and pneumococcal vaccine Control: 27.7% of patients had documentation of receiving the influenza and pneumococcal vaccine	High risk of bias -Study design -Selection bias (military only)	

Table 2: Characteristics of Studies that Assessed Pharmacists as Immunization Administrators

Study/ Design	Participants	Interventions/ Role of the Pharmacist	Outcomes	Results	Bias Assessment	Other Comments
Influenza						
[43] Grabenstein (2001) Cross sectional October 1998	Community pharmacy patients in Washington or Oregon 65 or older, or younger than 64 receiving specific medications (n=4403)	Intervention group: Survey sent to patients in a state where pharmacists can immunize (Washington) asking about beliefs and behaviours related to vaccination (n=2211, 1004 survey respondents) Control group: Survey sent to patients in a state where pharmacists cannot immunize asking about beliefs and behaviours related to vaccination (Oregon) (n=2192, 1086 survey	Vaccination rates for influenza	Intervention group: 34.7% of patients who were unvaccinated in 1997 were vaccinated in 1998 ≥65: 36.2% <65: 34.5% Control group: 23.9% of patients who were unvaccinated in 1997 were vaccinated in 1998 ≥65: 22.4% <65: 24.9% ≥65: Vaccination rates increased 4.7% in intervention group over control group between 1997 & 1998 (p=0.20)	High risk of bias -Study design -Patient survey (recall bias)	2,090 surveys returned (52%); 51% for Washington cohort, 55% for Oregon cohort

		respondents)		<65: Vaccination rates increased 10.6% in intervention group over control group between 1997 & 1998 (p=0.05)		
[44] Lam (2008) Quasi-experimental 2004 flu season (staring in October)	Patients in an assisted-living facility (n=123)	Intervention group: Patients receiving influenza vaccination from a pharmacist (n=70) Control group: Patients receiving influenza vaccination prior to implementation of pharmacist-run vaccination clinics (n=53)	Influenza vaccination rates	Intervention: 83% (58/70) patients vaccinated Control: 65% (34/53) patients vaccinated	High risk of bias -Study design -Limited to indigent, multiethnic, Asian patients	No incidence of adverse or allergic reaction occurred
[45] Loughlin (2007) Quasi-experimental October 1, 2003 – February 28, 2004 &	Patients from a secondary prevention lipid clinic (n=742)	Intervention group: Patients screened by clinical pharmacists, residents and students and offered influenza vaccination under a standing order	Influenza vaccination rates	Intervention: Vaccination rate of 76% Control: Vaccination rate of 39% Significant increase in vaccination rate	High risk of bias -Study design -Study was associated with the college of pharmacy	No adverse effects noted in patient medical records

October 1, 2004 – February 28, 2005		protocol (n=266) Control group: Prior to implementation, no formal immunization program in place (n=476)		after influenza vaccination program implementation (p<0.0001) After program implementation, patients <65 years of age were equally as likely as those ≥65 years of age to receive the influenza vaccination (76% vs 77%, />0.8)) compared to prior to implementation when younger patients were significantly less likely to receive the influenza vaccine (29% vs 58%, p<0.0001)		
[46] Marra (2014) Cluster randomized controlled trial 2009-2010	Patients of community pharmacies in British Colombia aged ≥65 years or <65 with a compelling indication	Intervention group: Pharmacies advertised for influenza immunization and sent personalized letters to eligible patients (n=28 pharmacies)	Influenza vaccination rates	Intervention: ≥65: 80.1% of patients immunized in 2010 <65: 54.0% of patients immunized Control: ≥65: 56.9% of patients immunized in	High risk of bias -Outcome assessor not blinded -Results could be effected because study was conducted	

		Control group: No pharmacy intervention. (n=25 pharmacies)		2010 <65: 70.8% of patients immunized Baseline (2009): Intervention pharmacies: 83.8% immunized Control pharmacies: 85.6% immunized	during time when H1N1 vaccination was also being administered	
[47] Steyer (2004) Quasi-experimental 1995-1999	Patients > 18 years old who responded to the Behavioural Risk Factor Surveillance System	Intervention group: States allowing pharmacists to immunize after 1997 Control group: States not allowing pharmacists to immunize after 1997	Influenza vaccination rates	Intervention: After pharmacists could immunize 68.4% of patients aged ≥65 and 25.5% of patients <65 were vaccinated compared to 57.7% of patients aged ≥65 years and 20.5% of patients aged <65 years of age before pharmacists could immunize Control: In 1999, 64.7% of patients aged ≥65 and 21.6% of patients aged <65 were vaccinated compared to 61.2% of patients	High risk of bias -Study design -Survey (self-reporting; recall bias) -Allocation by the state you live in	Odds ratio for being vaccinated in state allowing pharmacists to immunize vs not allowed to immunize: 18-64 years old, 1.27; 65+ years old, 1.22

				aged ≥65 years and 16.6% of patients aged <65 years of age in 1995 Vaccination rates in states where pharmacists could inject were significantly higher than rates in states where pharmacists cant inject for individuals aged ≥65 years ($p<0.01$)		
[48] Warner (2013) Quasi-experimental September – December, 2010	Community pharmacy users aged 12 years or older	Intervention group: Pharmacies advertised influenza vaccine and provided targeted information to all patients over 65 and those deemed high risk Control group: Usual care	Number of patients vaccinated for influenza	Intervention: ≥65: 70.3% vaccination rate <65: 51.2% vaccination rate Control: ≥65: 64.1% vaccination rate <65: 46.4% vaccination rate Vaccinations administered through pharmacies accounted for 9.7% of all patients vaccinated	High risk of bias -Study design -Unclear how it was compared to the control group	

				(2837/29395 patients vaccinated)		
Pneumococcal						
[49] Taitel (2011) Quasi-experimental November 15, 2009 – November 14, 2010	Patients who received influenza immunization also eligible for pneumococcal vaccination (n=2095748)	Intervention group: Pneumococcal risk assessed by pharmacists for patients immunized for influenza and offered vaccination if eligible (n=1343751) Control group: Usual care prior to program implementation (n=1204104)	Vaccination rates for pneumococcal vaccine	Intervention: 4.88% (65598 of 1343751 patients) received a pneumococcal vaccine Control: 2.90% (34917 of 1204104 patients) received pneumococcal vaccine Vaccination rate after the intervention was significantly higher than prior to intervention ($p<0.001$) Patients aged 60-70 years had the highest vaccination rate of 6.60%	High risk of bias -Study design	
Combination (influenza, pneumococcal & zoster)						
[50] Edwards (2012)	Patients aged ≥18 with diabetes at a university based	Intervention group: Planned care visit	Pneumococcal and influenza vaccination rates	Intervention: Vaccination rates of 80.5% for	High risk of bias -Study design	

Quasi-experimental August 2010 – April 2011	primary care clinic	with a pharmacist ~1 week prior to primary care appointment. Diabetes standards of care were completed with the pharmacist as needed. (n=94) Control group: Patients seen by family physicians with no pharmacist intervention. (n=210)		pneumococcal and 74.3% for influenza Control: Vaccination rates of 37.6% for pneumococcal and 50.0% for influenza Significant difference between intervention and control vaccination rates for both pneumococcal and influenza vaccinations (p<0.0001)	-No attempt to balance the allocation between groups, however the control group was randomly selected	
[51] Henry (2013) Quasi-experimental August 2010 – March 2011	Patients ≥18 seen at a primary care clinic with referral to pharmacist for type 1 or 2 diabetes mellitus, hypertension, hyperlipidemia, smoking cessation, or medication reconciliation (n=93)	Intervention group: Upon referral by physician, pharmacists provided information on disease management, including lifestyle factors, medications and point of care testing (A1C/BP) (n=93)	Vaccination rates of pneumococcal and influenza vaccine	Intervention: 44% influenza vaccination rate (41/92 patients) 52% pneumococcal vaccination rate (45/86 patients) Control: 30% influenza vaccination rate (28/92 patients) 31% pneumococcal vaccination rate	High risk of bias -Study design	

		Control group: Baseline data. (n=93)		(27/86 patients) Rates of vaccination against influenza (p=0.048) and pneumonia (p=0.005) were significantly improved after a patient was seen by a pharmacist		
[52] Higginbotham (2012) Randomized controlled trial November 2009 – February 2010	Uninsured, low income patients aged ≥18 from community pharmacies (n=101)	Co-intervention (protocol 2): Immunization needs assessment (INA) survey with results explained to patient and then offered to receive recommended vaccinations by pharmacist immunizer (n=28) Co-intervention (protocol 3): INA survey with results given by provision of vaccination sheet (stating which vaccinations are suggested), and	Number of immunizations received	Co-intervention (protocol 2): >18 times more likely to be current on immunizations than control (protocol 1), and >5 times more likely to be current than protocol 3 No significant differences when comparing protocol 1 and 3 Protocol 1 and 3 had higher immunization burden (needing more than 5 vaccinations	High risk of bias -Outcome assessor not blinded -Pharmacists recruited based on convenience sampling M,W,F -Protocol chosen based on the group that was followed for that particular day (so some protocols had more patients than others)	

		participants advised to share document with physician (n=36) Control (protocol 1) INA survey with results concealed. (n=37)				
[53] Taitel (2013) Quasi-experimental August 2011 – March 2012	Walgreens pharmacy users with a vaccination administration record (VAR) (n=46257)	Intervention group: Patients in states where pharmacists are authorized to administer vaccinations under a protocol or prescriptive authority. (n=34535 for pneumococcal; n=31639 for zoster) Intermediate group: Patients in states where pharmacists are authorized to administer vaccinations only with a patient	Number of patients vaccinated for pneumococcal and zoster vaccine	Intervention: 6.6% (1493/34535 patients) vaccinated for pneumococcal 3.3% (587/31639 patients) vaccinated for zoster Intermediate: 2.5% (109/6337 patients) vaccinated for pneumococcal 2.8% (127/7601 patients) vaccinated for zoster Control: 2.8% (115/5385 patients) vaccinated for pneumococcal 1% (50/7017 patients) vaccinated for zoster	High risk of bias -Sstudy design -Unclear if patients randomized into each group based on their severity of comorbid illness/ age or by state vaccination capabilities	

		specific prescription. (n=6337 for pneumococcal; n=7601 for zoster) Control group: patients in states where pharmacists are not authorized to administer vaccinations, though vaccines may be dispensed by pharmacists and administered by onsite nurses. (n=5385 for pneumococcal; n=7017 for zoster)		Pneumococcal: intervention vs intermediate p<0.0001; intervention vs control p<0.0001; intermediate vs control non-significant Zoster: intervention vs intermediate non-significant; intervention vs control p<0.05 (non-significant); intermediate vs control p<0.0001		
Other						
[54] Mills (2014) Quasi-experimental December 2008 – November 2012	Pharmacy users of Walgreens in or near a women's hospital	Intervention group: Tdap vaccine education program at 1 Walgreens pharmacy located on the Prenctice Women's Hospital, with referral for Tdap vaccination	Rates of Tdap vaccination Percentage of eligible close contacts of neonates who received Tdap vaccinations	Intervention: 2045 vaccines in intervention pharmacy (mean of 85.2 vaccines/ month/ pharmacy) 817 in comparison hospital pharmacies (mean of 8.5 vaccines/ month/	High risk of bias -Study design -Very different study locations evaluated	

		Comparison group 1: pre-study period; 4 hospital retail pharmacies at other sites with no intervention Comparison group 2: 44 retail pharmacies in close proximity to the Prentice Women's Hospital with no intervention		pharmacy) (p<0.001) 2930 in area-community pharmacies (mean of 2.8 vaccines/ month/ pharmacy) (p<0.001) Control: 31 Tdap vaccinations in the intervention pharmacy (mean of 1.3 vaccines/ month/ pharmacy) 77 in comparison hospital-campus pharmacies (mean of 0.8 vaccines/ month/ pharmacy) 155 in area-community pharmacies (mean of 0.1 vaccines/ month/ pharmacy) Estimated Tdap coverage per live births: 0.1% in the intervention		

				pharmacy during pre-study period vs. 8.1% during study period 0.5% in the comparison hospital campus pharmacies vs. 5.5% during the study period Tdap vaccination coverage level per live births was 46.7% greater in the intervention pharmacy than for the 4 comparison hospital pharmacies with no intervention program ($p<0.001$)		
[55] Otsuka (2013) Randomized controlled trial April – November, 2011	Patients aged ≥60 attending university internal medicine clinic (n=2589)	Intervention groups: Pharmacists reviewed charts and mailed a herpes zoster vaccine prescription to eligible patients Patients with a personal health	Number of patients vaccinated with zoster vaccine	Intervention: 13.2% (33/250 patients) with PHR were vaccinated 5.2% (13/250 patients) without PHR vaccinated Control: 5% (21/454 patients with PHR vaccinated	High risk of bias -Outcome assessor not blinded -Groups not evenly allocated	

		record (PHR) received information regarding the herpes zoster vaccination via an electronic message (n=250) Patients with no personal health record (nPHR) received information regarding the herpes zoster vaccination via postal service (n=250) Control groups: Patients with PHR received standard of care (n=424) Patients with no PHR received standard of care (n=1665).		1.8% (30/1665 patients) without PHR vaccinated PHR: Significant increase in vaccination rate after intervention (p=0.0001) No PHR: Significant increase in vaccination rate after intervention p=0.0007		
[56] Wang (2013)	Community pharmacy patients ≥60 years of age	Intervention group: Pharmacists	Number of patients vaccinated for	Intervention: 193 of 16062 eligible patients were	High risk of bias -Study design	

Quasi-experimental December 2007 – June 2008	eligible for herpes zoster vaccine	advertised herpes zoster vaccine through personalized letters mailed to pharmacy patients eligible for the vaccine, newspaper press regarding the vaccine & flyers given with every prescription released from the pharmacy Control group: Patients voluntarily presenting to pharmacies requesting herpes zoster vaccination prior to intervention period	Zoster	vaccinated Control: 59 of 16121 eligible patients were vaccinated Vaccination rates increased from 0.37% to 1.20% ($p<0.0001$) During the 4 months following intervention, vaccination rates decreased significantly to 0.5% ($p<0.0001$)	-Short assessment time – Assessed 2 different months of the year	