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Review Article

Pharmacist services provided in general practice clinics: A systematic review and meta-analysis

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Abstract

Background: Integration of pharmacists into primary care general practice clinics has the potential to improve interdisciplinary teamwork and patient care; however this practice is not widespread.
Objective: The aim of this study was to review the effectiveness of clinical pharmacist services delivered in primary care general practice clinics.
Methods: A systematic review of English language randomized controlled trials cited in the Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE and International Pharmaceutical Abstracts was conducted. Studies were included if pharmacists had a regular and ongoing relationship with the clinic; delivered an intervention aimed at optimizing prescribing for, and/or medication use by, clinic patients; and were physically present within the clinic for all or part of the intervention, or for communication with staff. The search generated 1484 articles. After removal of duplicates and screening of titles and abstracts against inclusion criteria, 131 articles remained. A total of 38 studies were included in the review and assessed for quality. Seventeen studies had common endpoints (blood pressure, glycosylated hemoglobin, cholesterol and/or Framingham risk score) and were included in meta-analyses.
Results: Twenty-nine of the 38 studies recruited patients with specific medical conditions, most commonly cardiovascular disease (15 studies) and/or diabetes (9 studies). The remaining 9 studies recruited patients at general risk of medication misadventure. Pharmacist interventions usually involved medication review (86.8%), with or without other activities delivered collaboratively with the general practitioner (family physician). Positive effects on primary outcomes related to medication use or clinical outcomes were reported in 19 studies, mixed effects in six studies, and no effect in 13 studies. The results of meta-analyses favored the pharmacist intervention, with significant improvements in blood pressure, glycosylated hemoglobin, cholesterol and Framingham risk score in intervention patients compared to control patients.
Conclusions: Pharmacists co-located in general practice clinics delivered a range of interventions, with favorable results in various areas of chronic disease management and quality use of medicines.

Keywords: Pharmacists; General practice; Primary health care; Systematic review; Meta-analysis

Conflict of interest: None.

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Introduction

General practice is defined as "the provision of primary continuing comprehensive whole-patient medical care to individuals, families and their communities".[1] In the provision of primary care, much undifferentiated illness is seen; the primary care physician or general practitioner (GP) must deal with problem complexes and make a total assessment of a patient's condition in a range of clinical contexts. In managing the patient, general practice staff may make referral to other health care professionals and community services, including pharmacists.[1]

There is evidence that non-dispensing or clinical services provided by pharmacists in the outpatient setting may result in improved patient outcomes and prescribing patterns.[2] Despite this, the uptake of these services is low and collaboration between pharmacists and general practitioners is suboptimal.[3,4] Limitations of most models of GP-pharmacist collaboration in primary care include geographical isolation, poor communication, and lack of time and remuneration for team activities.[5,6]

In recent years, pharmacists have increasingly integrated into general practice clinics.[7,8] Practice pharmacists have a range of functions including administrative and clinical duties related to their expertise in medication use and safety. Clinical services provided by these pharmacists include drug information, medication reviews, education and counseling, health promotion, and running disease management clinics.[9] The co-location of pharmacists with GPs in these settings has been shown to enable greater inter-professional communication and the development of collaborative working relationships.[10]

A systematic review by Fish et al[11] published in 2002 found that studies of general practice-based pharmaceutical services have largely been of poor methodological quality, with inconsistent results. Since that review was published, there has been a rise in the number of studies exploring the role of general practice-based pharmacists.

Other more recent systematic reviews of pharmacist interventions have focused on specific patient groups, disease states, interventions, and/or outcome measures in a diverse range of health care settings rather than in primary care general practice clinics specifically, thus making it difficult to apply findings to the general practice setting.[2,12–15]

The aim of the current systematic review was to evaluate the role of pharmacists co-located with GPs and other health professionals within primary care general practice clinics (e.g. family practice clinics, community health centers or primary health care centers). The review includes randomized controlled trials (RCTs) that explored a variety of pharmacist interventions covering different disease states and patient groups, and their effect on various health outcomes.

Methods

Search strategy

A search of the literature was undertaken using the Cochrane Central Register of Controlled Trials (CENTRAL) (1966 – May 2013), MEDLINE (1966 – May 2013), EMBASE (1966 – May 2013) and International Pharmaceutical Abstracts (IPA) (1970 – May 2013). In CENTRAL and MEDLINE, Medical Subject Headings (MeSH) related to pharmacy ("pharmacists" *or* "pharmaceutical services") *and* general practice ("family practice" *or* "primary health care" *or* "family physicians" *or* "physicians' offices" *or* "community health centers" *or* "community health services") were used. These were supplemented with truncated text words related to pharmacy ("pharmacist*") *and* general practice ("family adj2 practi*" *or* "general adj2 practi*" *or* "primary adj2 care" *or* "family adj2 physician" *or* "clinic"). EMBASE was searched using a similar strategy; however, the Emtree subject headings "pharmaceutical care" and "pharmacy" were used instead of "pharmaceutical services"; "general practice" and "general practitioners" were used instead of "family practice" and "family practitioners"; and the term "physicians' offices" was excluded, as it was not available. Searches were limited to randomized controlled trials (RCTs). IPA was searched using the key words "pharmacist*" *and* "primary care" *or* "primary health care" *or* "primary health care" *or* "general practice" *or* "family practice" *or* "family medicine" *or* "community health" *or* "office" *or* "clinic" AND "control*" *or* "random*." Descriptor terms were not utilized as these were considered to be too broad and non-specific. Searches were limited to English-language articles and excluded conference abstracts. Reference lists of studies identified, and other review articles related to pharmacist involvement in general practice, were screened for additional relevant studies.

Inclusion and exclusion criteria

Studies were included in the review if they met all of the following conditions:

- tested an intervention that included a pharmacist who
  - delivered one or more clinical pharmacy (non-dispensing) services aimed at improving prescribing and/or medication use in patients attending a general practice clinic;
  - had a regular and ongoing relationship with the clinic; and
  - was physically present within the clinic for all or part of the intervention, or for communication with clinic staff (however, may deliver interventions to individual patients remotely [e.g. via telephone or web] or in the patient's home [i.e., home visit]).
- had a control group;
- randomly assigned participants (patients or practices) to the study groups; and
- measured outcomes related to appropriateness of prescribing, medication use, health service use, clinical, functional, practice or economic outcomes.

Studies were excluded if they met any of the following conditions:

- tested infrequent or "once off" interventions such as academic detailing or similar interventions provided by an external group;
- the intervention was delivered in secondary or tertiary care hospital settings;
- tested interventions that did not target management of individual patients (e.g. the use of group education sessions or drug use evaluation only);or
- did not report an *a priori* sample size calculation, and the sample size was less than 50 subjects per group.[c]

Study selection

The titles and abstracts of studies were screened for relevance by one author (ET). Full-text copies were obtained if a study appeared to meet the inclusion criteria or it was unclear whether it would meet the criteria. Two authors independently reviewed the full text to assess studies' suitability for inclusion. Disagreements or uncertainties about study inclusion were resolved by discussion in the presence of all authors.

Data extraction and validity assessment

Data were extracted independently by two authors using a standardized abstraction form. Data extracted included study setting, duration, study population, sample size, intervention tested, outcome measures and results. Methodological quality was assessed according to the Cochrane Handbook risk of bias assessment tool[16] and included examining the following criteria: method of randomization, concealment of allocation, blinding of outcome assessment, addressing of incomplete outcome data and freedom from selective outcome reporting. Given the nature of the interventions assessed, blinding of the participants and personnel in the studies was not possible; and hence, these criteria were not included in the quality assessment. Attempts were made to contact authors to clarify details of the studies as needed.

The primary outcome measures for the intervention and control groups at the end of study were compared; a P value <0.05 was considered statistically significant. A 'positive outcome' was defined as a significant difference in favor of the intervention group for the primary outcome at study-end, with a 'negative outcome' being the opposite. 'No effect' was defined as no statistically significant difference between the groups. For studies assessing multiple primary outcomes, a 'mixed result' was defined as a positive outcome on one primary outcome measure but not another.

Meta-analysis

Where there were two or more studies that reported a similar primary outcome measure with appropriate extractable data, a meta-analysis was undertaken. Data extracted from these studies included sample size, means and standard deviations; if these were not reported, other data (e.g. P-values) were recorded where possible. Meta-analysis was performed using Comprehensive Meta-analysis (Biostat, Inc, Englewood, NJ). Random effects models were used for pooling the data and I^2 statistics were used for exploring heterogeneity.[17,18] The effect size for the meta-analysis was calculated as the difference in means. Weighted averages were used to pool each study and significance tested using a Z-statistic.

[c] Likely to be underpowered, with unacceptable risk of false negative findings.

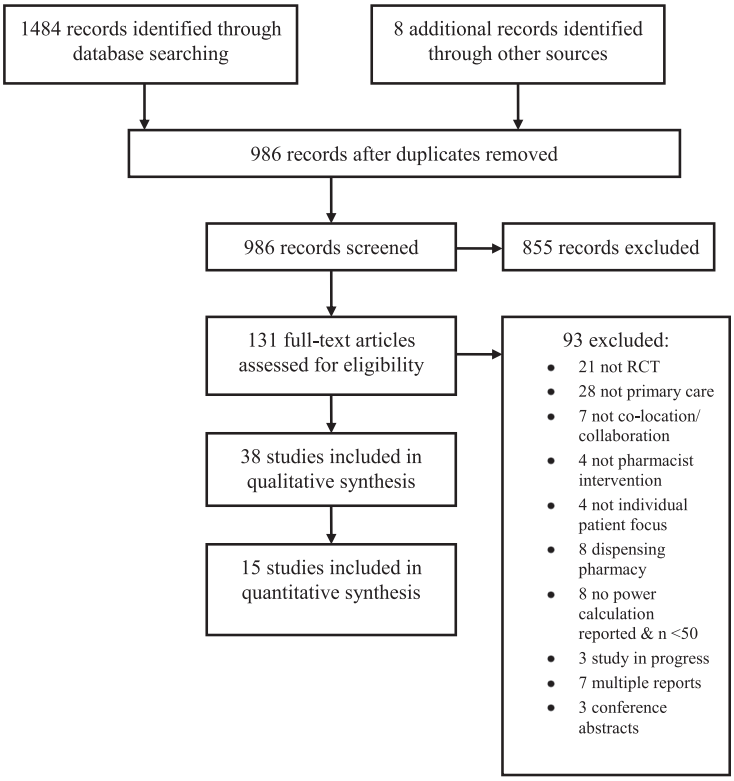


Fig. 1. Selection of studies.

Results

Search and study selection

The electronic database searches retrieved 1484 articles. An additional eight articles were identified by a manual search of relevant review articles and reference lists. After removal of duplicates, the titles and abstracts of 986 studies were reviewed, of which 855 were excluded because they clearly did not meet the inclusion criteria. 131 articles were deemed suitable for the retrieval of full-text copies for further scrutiny; 93 of these were excluded after review by at least two investigators (Fig. 1). A total of 38 studies were included in the final review and are summarized below and in Table 1.

Summary of included studies

The majority of studies were conducted in the United States of America (USA),[19–36] United Kingdom (UK)[37–43] or Canada.[44–49] Three studies were undertaken in South America[50–52] and four studies in Asia.[53–56] Twenty-nine trials included patients with specific medical conditions including cardiovascular disease,[20,23,27,28,33,38,41,42,45,51–55,57] diabetes,[24,27,29,31,32,34,35,49,50] depression,[19,21,25] metabolic syndrome,[56] pain,[40] chronic obstructive pulmonary disease (COPD)[57] and menopause[44] as part of their inclusion criteria. The remaining nine studies included patients receiving polypharmacy,[26,30,39,46,48] patients prescribed at least one medication,[43] patients at risk of medication problems,[22] patients at risk of adverse health problems (e.g. had at least one emergency department visit in the past year, multiple co-morbidities etc.),[47] and any general practice patients.[37]

The pharmacist interventions mainly involved medication review, either face-to-face with the patient[19,22–26,28–31,33–35,37,40–43,45,47–53,55,56] or based on clinic medical records only.[27,32,38,39,46] All studies described some form of collaboration between the pharmacist and the GP or primary care physician. Interprofessional communication was either verbal (face-to-face[19,21,23,24,26,28–30,35,37,39,41,42,45,47–49,54–56] or by

Table 1
Characteristics of included studies\

Author (year), country	Primary care population	Patient-directed activities							Communication with GP			Primary outcome(s)	Effect(s)
		Medication review	Education	Adherence assessment	Health/ lifestyle advice	Physical assessment (e.g. BP)	Monitoring	Prescribing/ adjusting/ administering therapy	Face to face	Phone	Written		
Adler (2004),[19] US	≥18 years old with depression	✓	✓	✓	✓				✓		✓	Antidepressant use rates at 6 months; severity of depression (modified BDI)	Mixed (positive for antidepressant use; no effect BDI score)
Avery (2012),[37] UK	General practices with electronic prescribing	✓	✓				✓		✓			Prescribing appropriateness indicators	Positive
Bond (2007),[38] UK	Angina & hypertension	✓ (of MR)									✓	Prescribing appropriateness indicators	Mixed
Borenstein (2003),[20] US	≥18 years old, capitated medical insurance, uncontrolled hypertension		✓	✓	✓	✓				✓		BP	Mixed (positive in SBP; no in DBP)
Capoccia (2004),[21] US	≥18 years old with new episode of depression, started on antidepressant medication		✓	✓	✓			✓	✓		✓	Depression symptoms (Hopkins SCL-20 score)	No effect
Carter (2001),[22] US	Patients at high risk of medication problems	✓	✓	✓			✓ (varied between sites)	✓ (varied between sites)				Patient satisfaction, health care use & costs, HRQoL	No effect
Carter (2008),[23] US	21–85 years old with hypertension	✓	✓	✓				✓	✓			BP & % patients at target BP level	Positive
Choe (2005),[24] US	Type 2 diabetes and most recent HbA_{1C} ≥8.0%	✓	✓		✓			✓	✓		✓	HbA_{1c}	Positive
Deschamps (2004),[44] Canada	Peri- and post-menopausal female patients, 48–52 years old		✓								✓	Perception of being informed about HRT; decisional conflict; satisfaction with	No effect

(*continued*)

Table 1(*continued*)

Author (year), country	Primary care population	Patient-directed activities							Communication with GP			Primary outcome(s)	Effect(s)
		Medication review	Education	Adherence assessment	Health/ lifestyle advice	Physical assessment (e.g. BP)	Monitoring	Prescribing/ adjusting/ administering therapy	Face to face	Phone	Written		
												education & decision made regarding HRT; adherence to HRT	
Evans (2010),[45] Canada	Cardiovascular risk (Framingham risk score ≥15%)	✓	✓		✓				✓		✓	Framingham risk score	No effect
Finley (2003),[25] US	Depression, newly starting antidepressant	✓	✓		✓			✓		✓	✓	Adherence to antidepressant drug therapy	Positive
Gourley (1998),[36,57,59] US	Adults with hypertension or COPD		✓	✓	✓							Medication compliance, health resource use, satisfaction, knowledge of disease, QoL, clinical and process outcomes (primary outcome not specified)	Mixed
Granas (1999),[39] UK	Repeat prescriptions with ≥3 items	✓ (of MR)							✓			MRP resolution	Positive
Grymonpre (2001),[46] Canada	≥65 years, ≥2 medications	✓ (of MR)	✓								✓	Medication adherence	No effect
Hammad (2011),[56] Jordan	Metabolic syndrome	✓	✓	✓	✓		✓		✓		✓	Metabolic syndrome status	Positive
Hanlon (1996),[26] US	≥65 years, ≥5 medications	✓	✓	✓					✓		✓	MAI	Positive
Hay (2006),[40,70] UK	≥55 years, pain/stiffness in knee	✓		✓			✓	✓			✓	WOMAC index	No effect
Heisler (2012),[27] US	Diabetes, poor BP control & adherence	✓ (of MR)	✓	✓		✓	✓	✓			✓	SBP	No effect
Hogg (2009),[47] Canada	At risk of health problems	✓	✓						✓			CDM QOC measures	Positive
Hunt (2008),[28] US	Hypertension	✓	✓	✓	✓	✓	✓	✓	✓		✓	BP	Positive

Jacobs (2012),[29] US	Type 2 diabetes; HbA_{1C} >8%	✓	✓	✓	✓	✓	✓ (with GP approval)	✓ (with GP approval)	✓	✓	✓	Targets for HbA_{1C} (≤7%), LDL (≤100 mg/dL) BP (≤130/80 mm Hg)	No effect	
Jameson (2001),[30] US	≥5 chronic medicines	✓	✓	✓	✓				✓			Medical & drug costs	No effect	
Jameson (2010),[30] US	≥18 years old, diabetes, HbA_{1C} ≥9.0%	✓	✓	✓	✓			✓ (insulin)	?	?	?	HbA_{1C}	No effect	
Jamieson (2010),[41] UK	Adults, BP >140/85 and on treatment	✓	✓	✓	✓		✓		✓		✓	BP	Positive	
Kirwin (2010),[32] US	≥18, diabetes mellitus (Type 1 or 2)	✓ (of MR)									✓	Rate of HbA_{1C} testing	No effect	
Lowrie (2012),[42] UK	≥18 years, left ventricular systolic dysfunction	✓	✓	✓	✓		✓	✓	✓		✓	Composite of death from any cause or hospital admission for worsening heart failure	No effect	
Mourao (2013),[50] Brazil	≥18 years, post-prandial capillary glucose ≥180 mg/dL, HbA_{1C} ≥7%	✓	✓	✓	✓						✓	HbA_{1C}	Positive	
Neto (2011),[51] Brazil	≥60 years, diabetes and/or hypertension diagnosis & on therapy	✓	✓	✓	✓						✓	Framingham risk score	Positive	
Okamoto (2001),[33] US	≥18 years old, essential hypertension	✓	✓			?	✓					SBP & DBP	Positive	
Rothman (2005),[34] US	Type 2 diabetes	✓	✓					✓		✓	✓	BP, HbA_{1C}, total cholesterol	Mixed (positive for BP and HbA_{1C} but not cholesterol)	
Scott (2006),[35] US	≥18 years old, type 2 diabetes	✓	✓		✓			✓ (vaccine)	✓			HbA_{1c}	Positive	
Sellors (2003),[48] Canada	≥65 years, ≥5 medications	✓							✓		✓	Number of daily doses	No effect	
Simpson (2011),[49] Canada	Type 2 diabetes	✓				✓	✓		✓			BP	Positive	
Sookaneknum (2004),[53] Thailand	≥18 years old, primary hypertension	✓	✓	✓	✓	✓					✓	BP	Positive	
Tahaineh (2011),[55] Jordan	≥18 years, dyslipidemia	✓	✓	✓	✓		✓		✓		✓	% patients at LDL cholesterol target level	Positive	

(*continued*)

Table 1(*continued*)

Author (year), country	Primary care population	Patient-directed activities						Communication with GP			Primary outcome(s)	Effect(s)
		Medication review	Education	Adherence assessment	Health/ lifestyle advice	Physical assessment (e.g. BP)	Monitoring	Prescribing/ adjusting/ administering therapy	Face to face	Phone	Written	
Tobari (2010),[54] Japan	40–79 years, SBP 140–179 mm Hg or DBP 90–109 mm Hg or on antihypertensive	✓	✓		✓		✓		✓	✓		BP	Positive
Villa (2009),[52] Chile	≥ 18 years old, dyslipidemia	✓	✓		✓							Lipid profile (total cholesterol, LDL, HDL, TGs)	Mixed (positive for all except HDL)
Zermansky (2001),[43] UK	≥ 65 years old, ≥ 1 prescription, living in community	✓	✓	✓							✓	Number of changes to repeat prescriptions over 12 months	Positive

BP = blood pressure; CDM QOC = chronic disease management quality of care; GP = general practitioner; HbA_{1C} = glycosylated hemoglobin; HF = heart failure; LDL = low density lipoprotein; MAI = Medicines Appropriateness Index; MR = medical record only; MRP = medication-related problem; QoL = quality of life; SBP = systolic blood pressure; WOMAC = Western Ontario & McMaster Universities Arthritis Index.

telephone[20,25,29,34,54]), written[19,21,24–29,32,34,38,40–46,48,50,51,53,55,56] or not specified.[22,31,36,52] The pharmacist intervention resulted in positive outcomes in 19 studies,[23–26,28,33,35,37,39,41,43,47,49–51,53–56] mixed outcomes in six studies,[19,20,34,36,38,52] and no effect in 13 studies (Table 1).[21,23,27,29–32,40,42,44–46,48]

Methodological quality of studies

The quality assessment of studies is summarized in Table 2. Thirty-three studies had appropriate randomization processes described, with the remaining five studies not explicitly stating the method of sequence generation used. Half of the studies did not clearly describe the methods used to conceal allocation of patients into groups and two studies did not use appropriate methods for allocation concealment (it appeared that patients were randomized before recruitment).[29,58] Adequate blinding of outcome assessment was explicitly described in only 15 studies, with the remaining studies either failing to mention blinding or using the intervention pharmacist also to collect outcome data. Most studies ($n = 35$) used intention to treat analysis for outcome assessment and/or explicitly reported attrition and exclusions. The remaining studies failed to adequately describe loss to follow up, or had differential attrition rates across groups. Almost all studies reported on outcomes as per their intended study protocol; however, one study also included extensive *post-hoc* analyses[59] and another may have selectively reported on additional *post hoc* measures.[22]

Meta-analysis

Meta-analysis was performed on eleven trials that reported blood pressure (BP) as an outcome measure,[20,23,28,29,33,34,41,49,53,54,56] five trials that reported glycosylated hemoglobin (HbA_{1C}),[24,29,34,35,50] three studies that reported cholesterol [29,34,52] and two studies that reported 10-year Framingham risk score as an outcome measure.[45,51] Three studies that measured these endpoints were excluded as suitable data were not available for extraction.[27,31,55]

Statistical heterogeneity across the studies assessing BP was moderate ($I^2 = 37.5\%$). All eleven studies reported data on systolic BP (SBP), while ten also reported diastolic BP (DBP). The results of the meta-analysis favored the pharmacist intervention, revealing a significant reduction in both SBP and DBP in intervention patients (Fig. 2a). The mean difference between

Table 2
Quality assessment[16] of included studies\

Reference	Sequence generation adequate	Allocation concealment adequate	Blinding of outcome assessment adequate	Incomplete outcome data addressed	Free from selective outcome reporting	Total 'Yes' (out of 5)
Adler (2004)[19]	Yes	Yes	Yes	No	Yes	4
Avery (2012[37]	Yes	Yes	No	Yes	Yes	4
Bond (2007)[38]	Yes	Yes	Yes	Yes	Yes	5
Borenstein (2003)[20]	Yes	No	No	Yes	Yes	3
Capoccia (2004)[21]	Yes	Unclear	Unclear	Yes	Yes	3
Carter (2001)[22,58]	Yes	No	Unclear	Yes	Unclear	2
Carter (2008)[23]	Yes	Unclear	Unclear	Yes	Yes	3
Choe (2005)[24]	Unclear	Unclear	Yes	Yes	Yes	3
Deschamps (2004)[44]	Unclear	Unclear	Unclear	Yes	Yes	2
Evans (2010)[45]	Yes	Yes	No	Yes	Yes	4
Finley (2003)[25]	Yes	Yes	Yes	Yes	Yes	5
Gourley (1998)[36,57,59]	Yes	Unclear	No	Yes	No	2
Granas (1999)[39]	Yes	Yes	Unclear	Yes	Yes	4
Grymonpre (2001)[46]	Yes	Yes	Yes	Yes	Yes	5
Hammad (2011)[56]	Yes	Yes	No	Yes	Yes	4
Hanlon (1996)[26]	Yes	Unclear	Yes	Yes	Yes	4
Hay (2006)[40]	Yes	Yes	Yes	Yes	Yes	5
Heisler (2012)[27]	Yes	Yes	Yes	Yes	Yes	5
Hogg (2009)[47]	Yes	Yes	No	Yes	Yes	4
Hunt (2008)[28]	Yes	Unclear	Yes	Yes	Yes	4
Jacobs (2012)[29]	Yes	No	Unclear	Yes	Yes	3
Jameson (2001)[30]	Yes	Unclear	Unclear	No	Yes	2
Jameson (2010)[31]	Yes	Unclear	No	Yes	Yes	3
Jamieson (2010)[41]	Yes	Yes	No	Yes	Yes	4
Kirwin (2010)[32]	Yes	Yes	Yes	Yes	Yes	5
Lowrie (2012)[42]	Yes	Yes	Yes	Yes	Yes	5
Mourao (2013)[50]	Yes	Unclear	Unclear	Yes	Yes	3
Neto (2011)[51]	Yes	Unclear	Yes	Yes	Yes	4
Okamoto (2001)[33]	Unclear	Unclear	No	Yes	Yes	2
Rothman (2005)[34]	Yes	Yes	No	Yes	Yes	4
Scott (2006)[35]	Yes	No	No	Yes	Yes	3
Sellors (2003)[48]	Yes	Yes	Yes	Yes	Yes	5
Simpson (2011)[49]	Yes	Yes	Yes	Yes	Yes	5
Sookaneknum (2004)[53]	Unclear	Unclear	No	Yes	Yes	2
Tahaineh (2011)[55]	Yes	Yes	No	Yes	Yes	4
Tobari (2010)[54]	Yes	Yes	Yes	Yes	Yes	5
Villa (2009)[52]	Unclear	Unclear	No	Unclear	Yes	1
Zermansky (2001)	Yes	Unclear	No	Yes	Yes	3

Yes = low risk of bias; No = high risk of bias; Unclear = not explicitly/sufficiently described in paper to reach a conclusion and unable to verify with author.

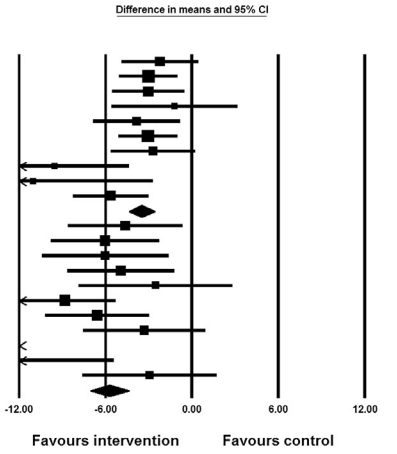
intervention and control groups in SBP was −5.72 mm Hg (95% CI, −7.05 to −4.39, $P < 0.001$) and DBP was −3.47 mm Hg (95% CI, −4.35 to −2.58, $P < 0.001$).

Statistical heterogeneity was low across the studies assessing HbA_{1C} ($I^2 = 0\%$). The results of the meta-analysis favored the pharmacist intervention, with significant reductions in HbA_{1C} (Fig. 2b). The mean difference between groups was −0.88% (95% CI, −1.15 to −0.62, $P < 0.001$).

Statistical heterogeneity was considerable across the studies assessing LDL-cholesterol ($I^2 = 77.38\%$) and total cholesterol ($I^2 = 53.93\%$). The results of the meta-analysis favored the pharmacist intervention, with significant reductions in LDL-cholesterol by 18.72 mg/dL

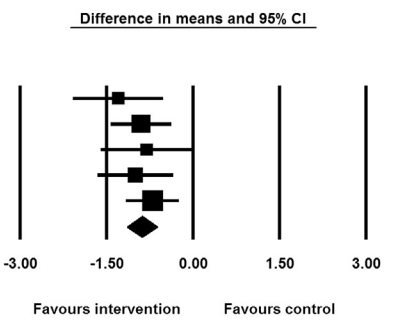
a **Blood Pressure (mmHg)**

Group by Subgroup within study	Study name	Subgroup	Statistics for each study						
			Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
DBP	Hammad, 2011	DBP	-2.20	1.35	1.81	-4.84	0.44	-1.63	0.102
DBP	Hunt, 2008	DBP	-3.00	1.03	1.06	-5.01	-0.99	-2.92	0.003
DBP	Rothman, 2005	DBP	-3.00	1.28	1.64	-5.51	-0.49	-2.35	0.019
DBP	Tobari, 2010	DBP	-1.20	2.22	4.93	-5.55	3.15	-0.54	0.589
DBP	Carter, 2008	DBP	-3.80	1.54	2.36	-6.81	-0.79	-2.47	0.013
DBP	Okamoto, 2001	DBP	-3.02	1.04	1.09	-5.07	-0.97	-2.89	0.004
DBP	Sookaneknum, 2004	DBP	-2.68	1.48	2.19	-5.58	0.22	-1.81	0.070
DBP	Jamieson, 2010	DBP	-9.50	2.62	6.88	-14.64	-4.36	-3.62	0.000
DBP	Borenstein, 2003	DBP	-11.00	4.23	17.88	-19.29	-2.71	-2.60	0.009
DBP	Jacobs, 2012	DBP	-5.60	1.33	1.77	-8.20	-3.00	-4.21	0.000
DBP	All studies		-3.47	0.45	0.20	-4.35	-2.58	-7.65	0.000
SBP	Hammad, 2011	SBP	-4.60	2.01	4.06	-8.55	-0.65	-2.28	0.022
SBP	Hunt, 2008	SBP	-6.00	1.91	3.65	-9.75	-2.25	-3.14	0.002
SBP	Rothman, 2005	SBP	-6.00	2.24	5.01	-10.39	-1.61	-2.68	0.007
SBP	Simpson, 2011	SBP	-4.90	1.89	3.57	-8.60	-1.20	-2.60	0.009
SBP	Tobari, 2010	SBP	-2.50	2.72	7.40	-7.83	2.83	-0.92	0.358
SBP	Carter, 2008	SBP	-8.80	1.79	3.20	-12.31	-5.29	-4.92	0.000
SBP	Okamoto, 2001	SBP	-6.56	1.83	3.36	-10.15	-2.97	-3.58	0.000
SBP	Sookaneknum, 2004	SBP	-3.30	2.15	4.63	-7.52	0.92	-1.53	0.125
SBP	Jamieson, 2010	SBP	-26.50	7.32	53.54	-40.84	-12.16	-3.62	0.000
SBP	Borenstein, 2003	SBP	-22.00	8.46	71.53	-38.58	-5.42	-2.60	0.009
SBP	Jacobs, 2012	SBP	-2.90	2.37	5.61	-7.54	1.74	-1.22	0.221
SBP	All studies		-5.72	0.68	0.46	-7.05	-4.39	-8.43	0.000



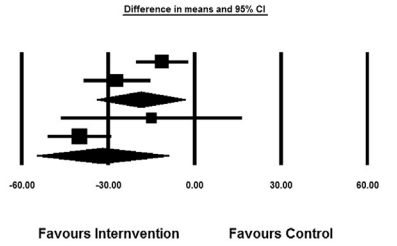
b **Glycosylated Hemoglobin (%)**

Study name	Statistics for each study						
	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Choe 2005	-1.300	0.397	0.158	-2.079	-0.521	-3.273	0.001
Mourao 2013	-0.900	0.265	0.070	-1.420	-0.380	-3.393	0.001
Rothman 2005	-0.800	0.406	0.165	-1.595	-0.005	-1.972	0.049
Scott 2006	-1.000	0.331	0.109	-1.648	-0.352	-3.025	0.002
Jacobs 2012	-0.700	0.232	0.054	-1.155	-0.245	-3.014	0.003
All studies	-0.884	0.136	0.018	-1.150	-0.618	-6.516	0.000



c **Cholesterol (mg/dL)**

Group by Subgroup within study	Study name	Subgroup within study	Statistics for each study						
			Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
LDL	Jacobs 2012	LDL	-11.300	4.609	21.239	-20.333	-2.267	-2.452	0.014
LDL	Villa 2009	LDL	-27.000	5.876	34.528	-38.517	-15.483	-4.595	0.000
LDL			-18.727	7.839	61.443	-34.090	-3.363	-2.389	0.017
Total	Rothman 2005	Total	-15.000	16.011	256.342	-46.380	16.380	-0.937	0.349
Total	Villa 2009	Total	-40.000	5.619	31.577	-51.014	-28.986	-7.118	0.000
Total	All studies		-31.995	11.664	136.042	-54.856	-9.135	-2.743	0.006



d **10 Year Framingham Risk Score (%)**

Study name	Statistics for each study						
	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Evans 2010	-0.300	1.522	2.317	-3.284	2.684	-0.197	0.844
Neto 2011	-2.400	0.555	0.309	-3.489	-1.311	-4.321	0.000
All studies	-1.828	0.935	0.874	-3.660	0.004	-1.956	0.050

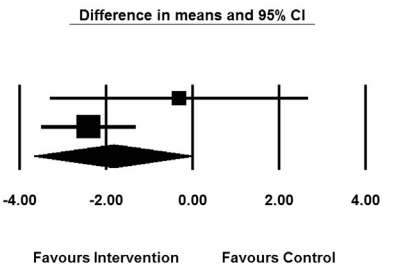


Fig. 2. (a–d) Forest plots of studies.

(95% CI, −34.10 to −3.36, $P < 0.017$) and total cholesterol by 32.00 mg/dL (95% CI, −54.86 to −9.14, $P < 0.006$) between groups (Fig. 2c).

Of the two studies assessing 10-year Framingham risk score reduction, heterogeneity was moderate ($I^2 = 40.5\%$). Pharmacist intervention resulted in a statistically significant reduction in 10-year Framingham risk score of −1.83% (95% CI, −3.66 to 0.00, P = 0.05) between groups (Fig. 2d).

Discussion

This systematic review and meta-analysis evaluated RCTs that investigated clinical services delivered by pharmacists co-located in general practice clinics. Findings from this review highlight the benefits of interprofessional communication and collaboration that occur with co-location.

Most studies (25/38) reported positive effects on at least one primary outcome measure. Positive effects were more often seen in studies that involved a pharmacist delivering a multifaceted intervention in conjunction with follow-up of patients, rather than delivering medication reviews, education or drug information in isolation. When pharmacists provided only medication management reviews with written or no communication with the patient's primary care physician, a positive effect was less likely to be observed. Positive effects were seen when medication review was combined with interprofessional face-to-face verbal communication. Studies that incorporated additional pharmacist interventions such as adherence assessment, health and lifestyle advice, medication initiation or adjustment, and monitoring, in conjunction with verbal communication (telephone or face-to-face) with the GP were also more likely to demonstrate improved outcomes. The importance of verbal inter-professional communication, especially the opportunity for bidirectional, face-to-face communication, has been recognized previously.[60] One study[29] that used multiple pharmacist interventions and all forms of interprofessional communication resulted in significant improvements in BP, HbA_{1C} and LDL cholesterol, but failed to achieve predefined targets for these parameters.

Studies included in this review showed that pharmacist services provided in general practice clinics can improve management of chronic conditions such as cardiovascular disease and diabetes. This is evidenced by improved BP, HbA_{1C} and cholesterol levels and attainment of health goals more often in the intervention groups compared with usual care. The current meta-analysis found improvements to cardiovascular parameters in favor of the intervention group, including a mean difference in SBP reduction of 5.72 mm Hg between intervention and control groups. Although modest, a reduction of this magnitude equates to a decrease in the risk of cardiovascular events by 20% over 5 years.[61] Meta-analysis also revealed a 0.88% reduction in HbA_{1C} in favor of the intervention group. A decrease of this magnitude is associated with a relative risk reduction of 25% for microvascular endpoints.[62] Pharmacist interventions in general practice clinics were also shown to improve the quality of prescribing and medication appropriateness. This was evidenced by positive effects on outcomes such as medication adherence, resolution of medication-related problems and indicators of quality of care. Pharmacist interventions tended to have limited or no effect on outcomes related to symptoms, quality of life, patient satisfaction and medical costs.

This review differs from previous systematic reviews and meta-analyses in that those tended to focus on specific interventions or outcomes,[13,63–66] or delivery of pharmacist interventions across a range of settings, whereas this one focused on pharmacists co-located with GPs and explored a broader range of pharmacist roles and outcomes, taking into account the generalist nature of the clinical pharmacist as a health care provider in primary care. This allowed for a broader assessment of the pharmacists' role in general practice, however heterogeneity in the nature of the interventions delivered (roles, format, duration and frequency of follow up of patients) and outcomes measured, made it difficult to compare studies and perform meta-analyses for all outcome measures. This was particularly evident in the various outcome measures for medication appropriateness, adherence and satisfaction. Standardization of outcome measures, as has been suggested in previous systematic reviews,[2] could assist in the comparison of interventions across multiple studies.

This systematic review and meta-analysis has some limitations. Although broad search strategies and manual checking of reference lists were undertaken to ensure all relevant studies were included, unpublished studies and studies published in languages other than English were not sought. Additionally, there were limitations to the studies included in this review. Several studies were conducted in single clinics or multiple clinics that were part of one organization or health care

group, and interventions were often delivered by a single pharmacist or specially trained pharmacist, limiting their external validity. Contamination of participants and Hawthorne effect also could not be ruled out. Pharmacists may have had existing relationships with the health professionals at these sites, thus influencing the ease of integration and acceptance of the pharmacist's role. Therefore the results of these studies may not be easily inferred in other settings. The outcomes assessed in these studies tended to be surrogate endpoints (e.g. BP) rather than direct endpoints of morbidity or mortality. Only one study[42] assessed death and hospitalization as primary outcomes, on which the pharmacist intervention had no effect. Further research in this area is needed, using outcome measures such as hospitalization and mortality to confirm beneficial outcomes for patients and practitioners, as well as cost-effectiveness.[11,13]

Additionally, this review found a lack of rigor in methodological quality of some included studies and difficulty comparing studies due to heterogeneity. These limitations also have been identified by other reviews.[2,11,15] Adequately powered multi-center trials that use cluster randomization, with sufficient follow up, blinding of outcome assessment and objective outcome measures to enhance the validity of the data are warranted. Additionally, explicit reporting of quality criteria, especially allocation concealment, is needed to ensure that studies produce evidence of high quality and reliability.

The positive impact of pharmacist co-location within general practice clinics identified in this review has implications for practitioners and policy-makers regarding the structure and dynamics of the primary health care workforce. Interdisciplinary medication management services within general practice clinics, especially for patients with cardiovascular disease and diabetes, would be valuable. Positive experiences from new models of collaborative practice in primary care involving pharmacists also support such services.[67,68] However, more support in terms of infrastructure, integration into the health care team, and sustainable funding models are critical for the adoption of pharmacists into general practice teams more widely.[69]

Conclusion

Pharmacists co-located in primary care general practice clinics delivered a variety of interventions, with favorable results seen in the management of cardiovascular disease, diabetes and some measures of quality use of medicines. Interventions were most effective when they were multifaceted and involved interprofessional collaboration with face-to-face communication. Co-location of pharmacists within general practice clinics may be an effective approach for delivery of patient-centered interdisciplinary medication management services.

References

1. Royal Australian College of General Practitioners. *What is General Practice?*, 2012. Available from: http://www.racgp.org.au/whatisgeneralpractice. Accessed 27.05.13.
2. Nkansah N, Mostovetsky O, Yu C, et al. Effect of outpatient pharmacists' non-dispensing roles on patient outcomes and prescribing patterns. *Cochrane Database Syst Rev*; 2010. CD000336.
3. Bell J, Kalisch L, Ramsay E, et al. Prescriber feedback to improve quality use of medicines among older people: the veterans' MATES program. *J Pharm Pract Res* 2001;41:316–319.
4. Pojskic N, MacKeigan L, Boon H, Ellison P, Breslin C. Ontario family physician readiness to collaborate with community pharmacists on drug therapy management. *Res Social Adm Pharm* 2011;7:39–50.
5. Dobson RT, Henry CJ, Taylor JG, et al. Interprofessional health care teams: attitudes and environmental factors associated with participation by community pharmacists. *J Interprof Care* 2006;20:119–132.
6. Edmunds J, Calnan MW. The reprofessionalisation of community pharmacy? An exploration of attitudes to extended roles for community pharmacists amongst pharmacists and General Practitioners in the United Kingdom. *Soc Sci Med* 2001;53:943–955.
7. Dolovich L. Ontario pharmacists practicing in family health teams and the patient-centered medical home. *Ann Pharmacother* 2012;46:S33–S39.
8. Bradley F, Elvey R, Ashcroft DM, et al. The challenge of integrating community pharmacists into the primary health care team: a case study of local pharmaceutical services (LPS) pilots and interprofessional collaboration. *J Interprof Care* 2008;22:387–398.
9. Farrell B, Ward N, Dore N, Russell G, Geneau R, Evans S. Working in interprofessional primary health care teams: what do pharmacists do? *Res Social Adm Pharm* 2013;9:288–301.
10. Dolovich L, Pottie K, Kaczorowski J, et al. Integrating family medicine and pharmacy to advance primary care therapeutics. *Clin Pharmacol Ther* 2008;83:913–917.

11. Fish A, Watson M, Bond C. Practice-based pharmaceutical services: a systematic review. *Int J Pharm Pract* 2002;10:225–233.
12. Hanlon JT, Lindblad CI, Gray SL. Can clinical pharmacy services have a positive impact on drug-related problems and health outcomes in community-based older adults? *Am J Geriatr Pharmacother* 2004;2:3–13.
13. Geurts MM, Talsma J, Brouwers JR, de Gier JJ. Medication review and reconciliation with cooperation between pharmacist and general practitioner and the benefit for the patient: a systematic review. *Br J Clin Pharmacol* 2012;74:16–33.
14. Haynes RB, Ackloo E, Sahota N, McDonald HP, Yao X. Interventions for enhancing medication adherence. *Cochrane Database Syst Rev*; 2008. CD000011.
15. Chisholm-Burns MA, Kim Lee J, Spivey CA, et al. US pharmacists' effect as team members on patient care: systematic review and meta-analyses. *Med Care* 2010;48:923–933.
16. Higgins J, Altman D, Sterne J. Chapter 8: assessing risk of bias in included studies. In: Higgins JPT, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (updated March 2011)*. *The Cochrane Collaboration*, 2011. Available from: www.cochrane-handbook.org.
17. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003;327:557–560.
18. Borenstein M, Hedges L, Rothstein H. *Meta-analysis: Fixed Effect vs. Random Effects*, 2007. Available from: http://www.meta-analysis.com/downloads/Meta-analysis%20fixed%20effect%20vs%20random%20effects.pdf. Accessed 30.08.13.
19. Adler DA, Bungay KM, Wilson IB, et al. The impact of a pharmacist intervention on 6-month outcomes in depressed primary care patients. *Gen Hosp Psychiatry* 2004;26:199–209.
20. Borenstein JE, Graber G, Saltiel E, et al. Physician-pharmacist comanagement of hypertension: a randomized, comparative trial. *Pharmacotherapy* 2003;23:209–216.
21. Capoccia KL, Boudreau DM, Blough DK, et al. Randomized trial of pharmacist interventions to improve depression care and outcomes in primary care. *Am J Health Syst Pharm* 2004;61:364–372.
22. Carter BL, Malone DC, Billups SJ, et al. Interpreting the findings of the IMPROVE study. *Am J Health Syst Pharm* 2001;58:1330–1337.
23. Carter BL, Bergus GR, Dawson JD, et al. A cluster randomized trial to evaluate physician/pharmacist collaboration to improve blood pressure control. *J Clin Hypertens* 2008;10:260–271.
24. Choe HM, Mitrovich S, Dubay D, Hayward RA, Krein SL, Vijan S. Proactive case management of high-risk patients with type 2 diabetes mellitus by a clinical pharmacist: a randomized controlled trial. *Am J Manag Care* 2005;11:253–260.
25. Finley PR, Rens HR, Pont JT, et al. Impact of a collaborative care model on depression in a primary care setting: a randomized controlled trial. *Pharmacotherapy* 2003;23:1175–1185.
26. Hanlon JT, Weinberger M, Samsa GP, et al. A randomized, controlled trial of a clinical pharmacist intervention to improve inappropriate prescribing in elderly outpatients with polypharmacy. *Am J Med* 1996;100:428–437.
27. Heisler M, Hofer TP, Schmittdiel JA, et al. Improving blood pressure control through a clinical pharmacist outreach program in patients with diabetes mellitus in 2 high-performing health systems: the adherence and intensification of medications cluster randomized, controlled pragmatic trial. *Circulation* 2012;125:2863–2872.
28. Hunt JS, Siemienczuk J, Pape G, et al. A randomized controlled trial of team-based care: impact of physician-pharmacist collaboration on uncontrolled hypertension. *J Gen Intern Med* 2008;23:1966–1972.
29. Jacobs M, Sherry PS, Taylor LM, Amato M, Tataronis GR, Cushing G. Pharmacist Assisted Medication Program Enhancing the Regulation of Diabetes (PAMPERED) study. *J Am Pharm Assoc* 2012;52:613–621.
30. Jameson JP, VanNoord GR. Pharmacotherapy consultation on polypharmacy patients in ambulatory care. *Ann Pharmacother* 2001;35:835–840.
31. Jameson JP, Baty PJ. Pharmacist collaborative management of poorly controlled diabetes mellitus: a randomized controlled trial. *Am J Manag Care* 2010;16:250–255.
32. Kirwin JL, Cunningham RJ, Sequist TD. Pharmacist recommendations to improve the quality of diabetes care: a randomized controlled trial. *J Manag Care Pharm* 2010;16:104–113.
33. Okamoto MP, Nakahiro RK. Pharmacoeconomic evaluation of a pharmacist-managed hypertension clinic. *Pharmacotherapy* 2001;21:1337–1344.
34. Rothman RL, Malone R, Bryant B, et al. A randomized trial of a primary care-based disease management program to improve cardiovascular risk factors and glycated hemoglobin levels in patients with diabetes. *Am J Med* 2005;118:276–284.
35. Scott DM, Boyd ST, Stephan M, Augustine SC, Reardon TP. Outcomes of pharmacist-managed diabetes care services in a community health center. *Am J Health Syst Pharm* 2006;63:2116–2122.
36. Gourley DR, Gourley GA, Solomon DK, et al. Development, implementation, and evaluation of a multicenter pharmaceutical care outcomes study. *J Am Pharm Assoc* 1998;38:567–573.
37. Avery AJ, Rodgers S, Cantrill JA, et al. A pharmacist-led information technology intervention for medication errors (PINCER): a multicentre, cluster randomised, controlled trial and cost-effectiveness analysis. *Lancet* 2012;379:1310–1319.

38. Bond CM, Fish A, Porteous TH, Reid JP, Scott A, Antonazzo E. A randomised controlled trial of the effects of note-based medication review by community pharmacists on prescribing of cardiovascular drugs in general practice. *Int J Pharm Pract* 2007; 15:39–46.
39. Granås A, Bates I. The effect of pharmaceutical review of repeat prescriptions in general practice. *Int J Pharm Pract* 1999;7:264–275.
40. Hay EM, Foster NE, Thomas E, et al. Effectiveness of community physiotherapy and enhanced pharmacy review for knee pain in people aged over 55 presenting to primary care: pragmatic randomised trial. *BMJ* 2006;333:995.
41. Jamieson L, Scally A, Chrystyn H. A randomised comparison of practice pharmacist-managed hypertension providing level 3 medication review versus usual care in general practice. *J Appl Ther Res* 2010;7:77–86.
42. Lowrie R, Mair FS, Greenlaw N, et al. Pharmacist intervention in primary care to improve outcomes in patients with left ventricular systolic dysfunction. *Eur Heart J* 2012;33:314–324.
43. Zermansky AG, Petty DR, Raynor DK, Freemantle N, Vail A, Lowe CJ. Randomised controlled trial of clinical medication review by a pharmacist of elderly patients receiving repeat prescriptions in general practice. *BMJ* 2001;6:1340–1343.
44. Deschamps MA, Taylor JG, Neubauer SL, Whiting S, Green K. Impact of pharmacist consultation versus a decision aid on decision making regarding hormone replacement therapy. *Int J Pharm Pract* 2004;12:21–28.
45. Evans CD, Eurich DT, Taylor JG, Blackburn DF. The Collaborative Cardiovascular Risk Reduction in Primary Care (CCARP) study. *Pharmacotherapy* 2010;30:766–775.
46. Grymonpre RE, Williamson DA, Montgomery PR. Impact of a pharmaceutical care model for non-institutionalised elderly: results of a randomised, controlled trial. *Int J Pharm Pract* 2001;9:235–241.
47. Hogg W, Lemelin J, Dahrouge S, et al. Randomized controlled trial of anticipatory and preventive multidisciplinary team care: for complex patients in a community-based primary care setting. *Can Fam Physician* 2009;55:e76–e85.
48. Sellors J, Kaczorowski J, Sellors C, et al. A randomized controlled trial of a pharmacist consultation program for family physicians and their elderly patients. *Can Med Assoc J* 2003;169:17–22.
49. Simpson SH, Majumdar SR, Tsuyuki RT, Lewanczuk RZ, Spooner R, Johnson JA. Effect of adding pharmacists to primary care teams on blood pressure control in patients with type 2 diabetes: a randomized controlled trial. *Diabetes Care* 2011; 34:20–26.
50. Mourao AO, Ferreira WR, Martins MA, et al. Pharmaceutical care program for type 2 diabetes patients in Brazil: a randomised controlled trial. *Int J Clin Pharm* 2013;35:79–86.
51. Neto PR, Marusic S, de Lyra Junior DP, et al. Effect of a 36-month pharmaceutical care program on the coronary heart disease risk in elderly diabetic and hypertensive patients. *J Pharm Pharm Sci* 2011;14: 249–263.
52. Villa LA, Von Chrismar AM, Oyarzun C, Eujenin P, Fernandez ME, Quezada M. Pharmaceutical care program for dyslipidemic patients at three primary health care centers: impacts and outcomes. *Lat Am J Pharm* 2009;28:415–420.
53. Sookaneknun P, Richards RME, Sanguansermsri J, Teerasut C. Pharmacist involvement in primary care improves hypertensive patient clinical outcomes. *Ann Pharmacother* 2004;38:2023–2028.
54. Tobari H, Arimoto T, Shimojo N, et al. Physician-pharmacist cooperation PROGRAM for blood pressure control in patients with hypertension: a randomized-controlled trial. *Am J Hypertens* 2010;23:1144–1152.
55. Tahaineh L, Albsoul-Younes A, Al-Ashqar E, Habeb A. The role of clinical pharmacist on lipid control in dyslipidemic patients in North of Jordan. *Int J Clin Pharm* 2011;33:229–236.
56. Hammad EA, Yasein N, Tahaineh L, Albsoul-Younes AM. A randomized controlled trial to assess pharmacist- physician collaborative practice in the management of metabolic syndrome in a university medical clinic in Jordan. *J Manag Care Pharm* 2011;17:295–303.
57. Solomon DK, Portner TS, Bass GE, et al. Clinical and economic outcomes in the hypertension and COPD arms of a multicenter outcomes study. *J Am Pharm Assoc (Wash)* 1998;38:574–585.
58. Carter BL, Malone DC, Valuck RJ, Barnette DJ, Sintek CD, Billups SJ. The IMPROVE study: background and study design. Impact of Managed Pharmaceutical Care on Resource Utilization and Outcomes in Veterans Affairs Medical Centers. *Am J Health Syst Pharm* 1998;55:62–67.
59. Gourley GA, Portner TS, Gourley DR, et al. Humanistic outcomes in the hypertension and COPD arms of a multicenter outcomes study. *J Am Pharm Assoc* 1998;38:586–597.
60. Zillich A, McDonough RP, Carter BL, Doucette WR. Influential characteristics of physician/pharmacist collaborative relationships. *Ann Pharmacother* 2004;38:764–770.
61. Glynn RJ, L'Italien GJ, Sesso HD, Jackson EA, Buring JE. Development of predictive models for long-term cardiovascular risk associated with systolic and diastolic blood pressure. *Hypertension* 2002;39:105–110.
62. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with

type 2 diabetes (UKPDS 33). *Lancet* 1998;352: 837–853.
63. Holland R, Desborough J, Goodyer L, Hall S, Wright D, Loke YK. Does pharmacist-led medication review help to reduce hospital admissions and deaths in older people? A systematic review and meta-analysis. *Br J Clin Pharmacol* 2008;65: 303–316.
64. Collins C, Limone BL, Scholle JM, Coleman CI. Effect of pharmacist intervention on glycemic control in diabetes. *Diabetes Res Clin Pract* 2011;92:145–152.
65. Morgado MP, Morgado SR, Mendes LC, Pereira LJ, Castelo-Branco M. Pharmacist interventions to enhance blood pressure control and adherence to antihypertensive therapy: review and meta-analysis. *Am J Health Syst Pharm* 2011;68:241–253.
66. Santschi V, Chiolero A, Burnand B, Colosimo AL, Paradis G. Impact of pharmacist care in the management of cardiovascular disease risk factors: a systematic review and meta-analysis of randomized trials. *Arch Intern Med* 2011;171:1441–1453.
67. Guillaume L, Cooper R, Avery A, et al. Supplementary prescribing by community and primary care pharmacists: an analysis of PACT data, 2004-2006. *J Clin Pharm Ther* 2008;33:11–16.
68. George J, McCaig DJ, Bond CM, et al. Supplementary prescribing: early experiences of pharmacists in Great Britain. *Ann Pharmacother* 2006;40:1843–1850.
69. Tan ECK, Stewart K, Elliott RA, George J. Integration of pharmacists into general practice clinics in Australia: the views of general practitioners and pharmacists. Int J Pharm Pract. http://dx.doi.org/10.1111/ijpp.12047 [Epub ahead of print].
70. Phelan M, Foster NE, Thomas E, Hay EM, Blenkinsopp A. Pharmacist-led medication review for knee pain in older adults: content, process and outcomes. *Int J Pharm Pract* 2008;16:347–355.

ARTICLE SYNOPSIS

Integration of pharmacists into primary care general practice clinics has the potential to improve interdisciplinary teamwork and patient care. A systematic review and meta-analysis of the effectiveness of clinical pharmacist services delivered in general practice clinics found that pharmacists delivered a range of interventions, most commonly medication review, and that these services often had favorable impacts on various aspects of chronic disease management and quality use of medicines. Pharmacist interventions were associated with significant improvements in blood pressure, glycosylated hemoglobin, cholesterol and Framingham risk score.