Pharmacist-led interventions to reduce unplanned admissions for older people: a systematic review and meta-analysis of randomised controlled trials

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Abstract

Purpose: medication problems are thought to cause between 10 and 30% of all hospital admissions in older people. This systematic review aimed to evaluate the effectiveness of interventions led by hospital or community pharmacists in reducing unplanned hospital admissions for older people.

Methods: eighteen databases were searched with a customised search strategy. Relevant websites and reference lists of included trials were checked. Randomised controlled trials were included that evaluated pharmacist-led interventions compared with usual care, with unplanned admissions or readmissions as an outcome. Two authors independently extracted data and assessed methodological quality.

Results: twenty-seven randomised controlled trials (RCTs) were identified; seven trials were excluded. The 20 included trials comprised 16 for older people and 4 for older people with heart failure. Interventions led by hospital pharmacists (seven trials) or community pharmacists (nine trials) did not reduce unplanned admissions in the older population (risk ratios 0.97 95% CI: 0.88, 1.07; 1.07 95% CI: 0.96, 1.20). Three trials in older people with heart failure showed that interventions delivered by a hospital pharmacist reduced the relative risk of admissions. However, these trials were heterogeneous in intensity and duration of follow-up. One trial had a high risk of bias.

Conclusions: evidence from three randomised controlled trials suggests that interventions led by hospital pharmacists reduce unplanned hospital admissions in older patients with heart failure, although these trials were heterogeneous. Data from 16 trials do not support the concept that interventions led by hospital or community pharmacists for the general older population reduces unplanned admissions.

Keywords: systematic review, meta-analysis, medication review, older people, pharmacist, unplanned admissions

Background

Increasing the role of pharmacists in initiatives to improve health and reduce health inequalities has been a target of the UK government since 1996 [1]. Key features of the UK government strategy include the role of the pharmacist in the prevention, identification and reporting of medication errors. In addition, pharmacists contribute to the care of people with long-term conditions by encouraging the effective use of medicine, promoting healthy lifestyles, supporting self-care, carrying out medication reviews and managing disease systematically within multi-professional teams [2]. The strategy
is aimed at all pharmacists including those working in the community, GP surgeries, hospitals, primary care trusts and strategic health authorities.

Older people (over the age of 60 years) using multiple medications may be at a greater risk of medication-related problems commonly caused by avoidable adverse reactions, interactions and poor adherence [3]. Medication-related problems are thought to cause between 10 and 30% of all hospital admissions in older people [4]. Estimates of non-adherence among the elderly vary from 21 to 55% with ~11% of admissions attributable to non-adherence [4]. Therefore, The National Service Framework for older people recommends annual medication reviews to reduce medicine-related problems and the NHS plan has proposed that pharmacists should play a key role in this [5].

Recent reviews have assessed the role of pharmacists in both primary and secondary care [6–8]. However, these reviews have not investigated the effect of pharmacist interventions on unplanned hospital admissions in older people. Thus, the aim of this review was to examine the impact of interventions led by pharmacists on reducing unplanned admissions in older people.

Methods
This systematic review was carried out across a wide range of electronic databases from inception to June 2010 (Supplementary data are available in Age and Ageing online, Table S1) to identify trials where the intervention was pharmacist-led or where pharmacist had a key role, and the primary or secondary outcome was to reduce unplanned hospital admissions or readmissions in older people. The review was conducted in accordance with PRISMA guidelines.

Inclusion criteria
Inclusion criteria were randomised controlled trials (RCTs) of pharmacist-led interventions conducted in primary or secondary care in which one of the outcomes was the number of unplanned admissions or readmissions that were either published in English or had an English abstract and that were carried out in an Organisation for Economic Co-operation and Development (OECD) country [9]. This latter criterion was chosen so that the results could be broadly applicable to the UK and other similar health systems. Unplanned/emergency or unscheduled hospital admissions were defined as ‘admission or readmission that was not previously planned or scheduled or “elective”’. Older people were defined as those aged 60 years or over.

Searches
The search strategy (Supplementary data are available in Age and Ageing online, Table S2) was designed in OVID Medline using a combination of text words and Medical Subject Headings. Using a set of key papers known to the group, the strategy was further refined to ensure a good balance of sensitivity and specificity. For the rest of the databases, search terms were adapted according to the search capabilities of each particular database.

The following websites were searched using the key term of ‘hospital admissions’.


Reference lists of all included trials and previous systematic reviews were checked for additional relevant publications. The flow of information through the review is presented as a PRISMA flowchart (Figure 1).

Data collection and analysis

Selection of studies
Two reviewers independently screened each reference title and abstract (if available) for relevance to this review. Where there was disagreement, a third reviewer made the final decision.

The full article was obtained for RCTs included from the first round of screening. The second round of screening involved one of two reviewers assessing full articles based on the agreed inclusion and exclusion criteria. Only non-English articles reaching the second round were translated in full to English. Exclusions were checked by a third reviewer at this second screen. Data were extracted by one reviewer, into Cochrane Review Manager Software version 5.1 and then checked by a second reviewer.

Assessment of risk of bias in included trials
The risk of bias was assessed in each study using the Cochrane risk of bias tool [10]. This is a domain-based evaluation, in which critical assessments are made over separately seven domains: sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessors, incomplete outcome data, selective reporting and other sources of bias. Using the Cochrane tool, each domain was rated as high, low or of unclear risk of bias.

Data synthesis
Outcome data in the included trials were reported in different formats: the total number of unplanned admissions or readmissions and the number of patients experiencing (single or multiple) admission or readmission. We attempted to contact authors if data were incomplete or were not in a usable form two of which provided information on the number of unplanned hospital admissions.

The outcome of number of patients with an admission or readmission was treated as dichotomous and using Review Manager Version 5.1; individual risk ratios were calculated. Total numbers of admissions were treated as count data and rate ratios calculated [10]. The total number of admissions was also dichotomised using the Poisson distribution to
estimate the probability of one or more unplanned admissions, allowing calculation of risk ratios [10]. Both risk and rate ratios are presented with their 95% confidence intervals (95% CI). All trials were analysed within populations (i) by the location of the review (hospital or community) and (ii) across community and hospital settings by the duration of the trial.

If there were at least three trials in which admissions or readmissions were measured a meta-analysis was performed with a fixed or random effects model depending on the level of between trial heterogeneity estimated using the $I^2$ statistic [10]. Sensitivity analysis was performed as the data dictated [10].
Pharmacist-led interventions to reduce unplanned admissions for older people

Results

We identified 27 RCTs that examined interventions led by pharmacists for older people (Figure 1). After review of the full papers against the inclusion and exclusion criteria, a total of 20 trials were included [11–30]. These were conducted in the UK (n = 9), elsewhere in Europe (n = 5), America (n = 3), Australia (n = 2) and Canada (n = 1). There were 16 trials of the general older population [11–26] and 4 trials of the older population with heart failure [27–30].

Trial characteristics

The interventions were all provided by pharmacists either in the hospital (10 trials) [11–17, 27–29] or in community settings (10 trials) (Table 1) [18–26, 30]. Those studies conducted in the hospital setting consisted of pharmacists compiling accurate lists of patients medications either at admission or prior to discharge with recommendations provided to the physician in charge of care in either written or oral communications [11–17, 27–29]. In addition, eight of these trials also provided education and counselling to patients to address issues of adherence and increasing knowledge of their conditions and awareness of medications [13–17, 27–29]. In six of these trials, the intervention continued after discharge from hospital with either telephone- or home-based monitoring [15–17, 27–29].

In community-based programmes, four of the trials were conducted in the pharmacy when a patient returned for a repeat prescription [24–26, 30]. These involved the pharmacist checking the items were required, compliance and any side effects or interactions. One study was conducted in the primary care physician office [23]. This intervention involved a structured medication assessment from the patient medical records. Written recommendations were provided to the physician with a pharmacist–physician meeting to discuss recommendations. The remaining five trials were conducted in the patient’s home with recommendations provided to the primary care physician for action [18–22]. During the home visits, pharmacists assessed compliance, and any possible drug reactions and interactions, and removed any out-of-date drugs. In addition, they provided education and counselling about the medications and disease/conditions the patients had and compliance aids when required. Overall only 7 out of the 20 trials gave information on recommendations made or acted on by pharmacists. (Table 1) [11, 12, 14, 15, 19–21].

Risk of bias

All 20 trials were at a high risk of performance bias because the nature of the intervention meant that personnel and participants could not be blinded (Figure 2). Only three trials were considered at low risk of bias in all remaining domains [17, 19, 23]. The domain in which bias could not be assessed most often was allocation concealment in which eight trials did not provide enough information for assessment [11, 14, 18, 20, 24–26, 29]. There was a high risk of other bias assessed in 10 trials which included possible contamination bias in four trials with the same pharmacists caring for both control and intervention groups, four trials lacked power to detect changes in admission rates and three trials recruited only half of the eligible patients into the trial [14–16, 18, 20, 21, 25–27, 29].

Trials involving older people (n = 16 trials)

Seven of these trials used a hospital pharmacist [11–17] and nine used community pharmacists [18–26]. Overall these trials would be considered at a moderate risk of bias with only two of at low risk of bias [12, 17] (Figure 2).

Of the trials using hospital-based pharmacists three trials included post discharge follow-up [15–17]. One trial followed up with a telephone call at 2 months to ensure adequate home management of medications [15]. The second trial used regular follow-up appointments at 1, 2–4 weeks, 2 months and 3 months post discharge [16]. The remaining trial used a hospital pharmacist for patients discharge planning, and community pharmacists for home-based follow-up at 7–14 days, with further visits arranged at their discretion [17].

There was no effect on the number of unplanned admissions with inpatient intervention only (n = 4, pooled RR: 0.91; 95% CI: 0.79, 1.06), inpatient intervention with follow-up (n = 3, pooled RR: 1.01; 95% CI: 0.89, 1.15) or all hospital interventions (n = 7, RR: 0.97, 95% CI: 0.88, 1.07) (Figure 3a).

Nine trials utilised community pharmacists [18–26]. These studies were judged overall to be at a moderate risk of bias (Figure 2). Three trials were conducted in the pharmacist’s shop or office when the patient attended for a repeat prescription [18, 25, 26]. In five trials, the pharmacists conducted home visits and used the medical notes of the primary care physician [19–22, 24]. The remaining trial conducted medication assessments by interviewing the patients in the primary care physician’s office [23].

There was no reduction in unplanned hospital admissions from these trials (n = 9, pooled RR: 1.07, 95% CI: 0.96, 1.20) (Figure 3b). Removing the one study that was at high risk of bias did not alter these findings (n = 8, pooled RR: 1.08, 95% CI: 0.96, 1.21) [18]. These trials were also grouped by the time at which hospital admission data were collected at 3, 6 and 12 months. There was no effect on unplanned admissions at any of these time points: at 3 months the pooled RR for three trials was 0.73 (95% CI: 0.49, 1.06), at 6 months the RR was 1.16 (95% CI: 0.99, 1.35) for six trials and at 12 months the RR was 0.95 (95% CI: 0.81, 1.11) for six trials.

Trials involving the older population with heart failure (n = 4 trials)

There were four trials which assessed medication review in the older population with heart failure [27–30]. Three trials used pharmacists in hospital and following discharge [27–29]. The remaining trial involved community pharmacists only [30].

The three hospital pharmacist trials provided follow-up of patients. Lopez et al. [27] monitored patients following discharge by telephone monthly for the first 6 months and every 2 months for the remaining 6 months. In Stewart et al.
<table>
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<tr>
<th>Trial country</th>
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<tr>
<td>Lisby et al. [11]</td>
<td>99 patients (30% female) who were ≥70 years and using &gt;1 medication. (95% CI: 78.3, 82.1) Population had &gt;40 different conditions but most common pneumonia, COPD and suspected MI</td>
<td>50 patients who were followed up for 12 months. Within 24 h of admission or by the first coming day of the week. (i) Pharmacists collected information about patient's medication and discussed with clinical pharmacist. (ii) Errors and recommendations were then written into an advisory log.</td>
<td>49 patients A review by junior physician on admission and within 24 h an assessment by a senior physician specialised in internal medicine.</td>
<td>(i) Number of patients 11 versus 11 (ii) Total number of admissions 13 versus 12 187 recommendations were reported and 73 were accepted. The recommendations were followed in 28 patients and not followed in 16. No recommendations were made in six patients.</td>
<td>(i) RR 0.98 (ii) Rate Ratio 1.06 (95% CI: 0.47, 2.05) (95% CI: 0.48, 2.33)</td>
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<td>Denmark data on unplanned admissions provided by author</td>
<td>503 patients (64% female) admitted to four internal medicine wards and five intensive care unit with an average age of 61 years (95% CI: 58, 64)</td>
<td>126 patients followed up for 30 days. Five pharmacists attended physician rounds or reviewed patient's medication profiles. A further pharmacist assessed the appropriateness of physician's requests on an antibiotic approval pager. Interventions were recorded over 30 days and were characterised as either quality of care or cost saving.</td>
<td>133 patients usual care—no details provided</td>
<td>Number of patients 25 versus 22 126 interventions were made and almost all were universally accepted by the patient's primary care physician</td>
<td>RR: 1.20 (95% CI: 0.71, 2.01)</td>
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<td>Mcnulilin et al. [12]</td>
<td>762 patients (45% female) using at least four medications or high-risk drugs with a mean age of 70.3 years (SD: 13.8)</td>
<td>371 patients followed up for 12 months. Accurate medication history gathered on admission by pharmacist. Pharmacy technicians used algorithm to assess safety and suitability of patients own drugs for return on patient discharge. Drug treatment reviewed daily by pharmacist. Counselling tailored to individual needs provided by pharmacists and technicians. Medicines record sheet faxed to the patients GP and community pharmacist.</td>
<td>391 patients Traditional clinical pharmacy services.</td>
<td>Number of patients 141 versus 172</td>
<td>RR: 0.86 (95% CI: 0.73, 1.03)</td>
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<td>Scullin and McElhany [13]</td>
<td>Northern Ireland</td>
<td>89 patients who were followed up for 12 months. Pharmacist participated in clinical rounds, had contact with patients and care givers and access to medical records. Medication history on admission. At discharge pharmacist provided written and oral information on treatment changes to patient or caregiver and written information to GP.</td>
<td>83 patients Care provided by multidisciplinary team from geriatric evaluation and management clinic without input from clinical pharmacist</td>
<td>(i) Number of patients 29 versus 28 (ii) Rates of admissions 32.6% versus 33.7% 1,066 interventions 87.8% were fully accepted 7.2% were partially accepted and 5% were rejected</td>
<td>RR: 0.97 (95% CI: 0.63, 1.48)</td>
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### Hospital inpatient interventions with follow-up: older population

**Gillespie et al. [15]**  
**Sweden**  
400 patients (77% female) from two acute internal medicine wards with the mean age of 86.4 years (SD: 4.2). Main conditions/diseases at randomization included heart disease, diabetes, hypertension and dementia.

199 patients followed up for 12 months
- Comprehensive drug therapy review performed by pharmacist on admission.
- Advice given to patient's physician with final decision made by physician in charge.
- Patients monitored and educated throughout.
- Counselling provided to patients regarding newly commenced or discontinued drugs. Information about discharge medications communicated to primary care physicians.

201 patients
- Standard care without pharmacist involvement in the healthcare team at the ward level.

(i) Number of patients  
106 versus 110

(ii) Total number of admissions  
217 versus 223

Paper reported 476 drug related problems; 75% of actions were carried out by GPs.

(i) RR: 0.98  
(95% CI: 0.83, 1.17)

(ii) Rate ratio 0.98  
(95% CI: 0.82, 1.18)

**Lipton and Bird [16]**  
**USA**  
706 patients ≥65 years and a mean age 74.6 years with ≥3 medications for a chronic condition.

350 patients
- Reviewed before discharge, post discharge 1 week, 2–4 weeks, 2 months and 3 months 6 months.
- Pharmacists reviewed medical records and drug regimens in consultation with patients and physicians.
- Booklets provided on discharge to record medication information, e.g., drug purpose, dosage and schedule.
- Pharmacists conducted consultation before discharge to discuss purpose and the use of medications. The majority were provided by telephone and others took place in pharmacist's hospital office or in patient's home.

356 patients
- Patients provided with booklets on discharge in which to record medication information.

(i) Number of patients  
128 versus 118

(ii) Total number of admissions  
128 versus 118

No details on recommendations made or acted on.

(i) RR: 1.09  
(95% CI: 0.89, 1.33)

(ii) Rate ratio 1.10  
(95% CI: 0.86, 1.42)

**Nazareth et al. [17]**  
**UK**  
362 patients (62% female, 97% white) >75 years and a mean age of 84 years (SD: 52) using ≥4 medicines. Patients had a mean of three chronic medical conditions.

181 patients followed up for 6 months
- Discharge planning with home visits at 7–14 days post discharge and further visits as pharmacists discretion.
- Pharmacists performed integrated discharge plan including liaison with carers and community professionals where appropriate.
- Copy was given to patient, community pharmacist of their choice, GP and any other carers/professionals. At home visit they checked for any discrepancies between medicines and those prescribed on discharge. Interventions included counselling on purpose and appropriate doses of medication, disposing of excess medicines and liaising with GPs.

181 patients
- Discharged from hospital using standard procedures.

Number of patients
- (i) 3 months 64 versus 69
  
- (ii) 6 months 38 versus 43

No details on recommendations made or acted on.

(i) RR: 0.98 (95% CI: 0.68, 1.42)  
(ii) 6 months (1.42, 6 months)
### Table 1. Continued

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<tr>
<th>Trial country</th>
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<td>Number of patients</td>
<td>RR: 1.04 (95% CI: 0.75, 1.46)</td>
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<td>54 versus 80</td>
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<td>No details on recommendations made or acted on</td>
<td>1.46</td>
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#### Community pharmacists: older population

**Bond et al. [18]**

Scotland

2,301 patients (39.3% female) using repeat prescriptions with the mean age of 68 years (range 59–75)

904 patients followed up for 12 months

Monthly protocol checks and GP 3 monthly review.

Pharmacists provided patients with 3 monthly instalment prescriptions to last until review date set by GP according to clinical need. The prescriptions were kept by pharmacist of the patient’s choice and dispensed monthly following a protocol. Information was recorded on specially designed patient record cards retained by pharmacist.

1,397 patients

Usual care

No details provided

#### Holland et al. [19]

UK

872 patients (38.9% female) ≥80 years and with a mean age of 85.4 years (SD 4.0) and had ≥2 prescribed medications:

32.5% CV disease 14.7% musculo-skeletal, 11.8% GI 11.3% respiratory 7.6% neurological, 2.5% cancer, 19.4% other

415 patients followed up for 6 months

One home visit following recruitment and one follow-up visit 6–8 weeks later.

Pharmacists arranged home visits and assessed patient’s ability to self-medicate and drug adherence. If compliance aid recommended, this was provided within trial and a filling fee was paid to local pharmacist.

414 patients

Usual care

No details provided

(i) Number of patients 162 versus 133 (ii) Total admissions 234 versus 178 (iii) Rate ratio 1.29

933 recommendations were made to GP 2.58 per patient visited but no information provided on the number accepted or acted on by GP.

#### Krska et al. [20]

UK

381 patients (56.5%) female ≥65 years with a mean age of 74.8 years (SD: 6.2) using ≥4 medications and ≥2 chronic diseases

168 patients followed up for 3 months

One home visit followed by GP contact and agreed action plans applied.

Pharmacists completed detailed profiles for patient using medical notes and practice computer records. All patients interviewed in own homes and pharmaceutical care plan drawn up for patient. Copies of plan put in medical notes and GP asked as to their level of agreement. The pharmacist implemented all remaining agreed actions

164 patients

Patients interviewed and pharmaceutical care issues identified but no care plan was implemented.

Patients advised to contact usual carers or health professionals in response to direct queries

Number of admissions 6 versus 8 1,206 pharmaceutical care issues reported and 1,053 GPs agreed with the action for resolving them

RR: 0.73 (95% CI: 0.26, 2.06)

#### Lenaghan et al. [21]

UK

136 patients ≥80 years and ≥4 medications

No further details

66 patients followed up for 6 months

First visit within 2 weeks of consent with follow-up visit 6–8 weeks later. Pharmacist and GP had regular meetings

Patient’s current medication and medical history used to highlight areas to be addressed by pharmacist. Wherever possible home visit was arranged so pharmacist could meet carers. The pharmacist educated patient, removed out of date drugs and assessed need for adherence aid and had regular meetings with lead GP

69 patients

Usual care

No details provided

(i) Number of patients 17 versus 17 (ii) Total number 58 versus 87 (iii) Rate ratio 0.92

71 recommendations that required action by the GP 60 of which were acted upon

RR: 1.05 (95% CI: 0.58, 1.87)

(iii) Rate ratio 0.50, 1.71
Naunton and Peterson [22] Tasmania
121 patients (56% female) ≥60 years with a mean age of 74 years (range 65–90) and ≥2 chronic conditions and ≥4 prescribed medications
57 patients followed up for 3 months
First home visit 5 days post discharge, follow-up visit 90 days
Pharmacist's review aimed to educate patients, answer any patient/caregivers queries, optimise medication management and improve compliance, detect adverse reactions and improve liaison with community-based health services. They performed comprehensive medication review and sent letter to GP. After home visit the study pharmacist contacted patient's GP and community pharmacist to inform them of study
64 patients
Usual care
The pharmacist had no contact with the control groups until 90 days after discharge from hospital. They were then visited at home and provided with a comprehensive medication review
Number of patients RR: 0.62 (95% CI: 0.38, 1.06)
16 versus 29 No details on recommendations made or acted on

Sellors et al. [23] Canada
Data for number of admissions provided by authors
889 patients (64.3% female) ≥65 years with a mean age of 74.0 years (SD: 6.1) using ≥5 medications
431 patients followed up for 5 months
Initial consultation with pharmacist followed by GP consultation. Further GP-pharmacist consultations at 3 and 5 months and pharmacist-patient telephone monitoring at 1 and 3 months.
Structured medication assessment by pharmacist in physician's office. After interview pharmacist wrote letter to physician and they meet to discuss. Physicians used data collection form to indicate which recommendations they intended to implement and when
458 patients
Usual care
No details provided
Number of patients
(i) Number of patients (ii) Total admissions (iii) Rate (95% CI:)
52 versus 46 0.83, 1.75
53 versus 50 1.13 (95% CI:
No details on recommendations made or acted on
0.77, 1.66)

Taylor et al. [24] USA
69 patients (73.5% female, 60.6% white) with a mean age of 64.4 years (SD: 13.7) at a high risk for medication-related adverse events, ≥5 medications, ≥3 diseases/conditions, history of non-compliance
Four most common diseases were: hypertension (51%), dyslipidaemia (40%), diabetes (27%) and osteoarthritis (12%).
33 patients who were followed for 12 months
Regularly scheduled visits
Published therapeutic algorithms and guidelines were used as basis of pharmacist's recommendations which were communicated to GPs. Pharmacist also provided drug and disease information during the follow-up visits and answered patient's questions including written materials. The pharmacists monitored patient's responses to drugs and helped improve compliance
36 patients
Usual care
No details provided
Number of patients
(i) Number of patients (ii) Total admissions (iii) Rate (95% CI:)
2 versus 9 (0.06, 1.04)
2 versus 11 0.20 (95% CI:
No details on recommendations made or acted on
0.04, 0.89)

Zermansky et al. [25] UK
1,188 patients (56% female) ≥65 years with a mean age of 74 years (SD 6.6) and at ≥1 on repeat prescription
608 patients followed up for 12 months
Pharmacist invited patients to his clinic at next review. Changes were implemented either by pharmacist or in consultation with GP. Patient education as needed. Pharmacist recorded all recommendations and implementations communicated these with patient and GP
580 patients
Normal medical care from GP and primary healthcare staff
Number of admissions
(i) Number of admissions (ii) Total admissions (iii) Rate (95% CI:)
110 versus 92 0.68, 1.46
No details on recommendations made or acted on

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<tr>
<td>Zermansky et al. [26]</td>
<td>661 patients (77.3% female) ≥65 years with a mean age of 85.3 years and ≥1 repeat medications</td>
<td>331 patients followed up for 6 months</td>
<td>Clinical medication review conducted by study pharmacist within 28 days of randomisation. It was a review of GP clinical record and consultation with the patient and carer. The pharmacist formulated recommendations with the patient and carer and passed them on a written proforma to GP for acceptance and implementation</td>
<td>330 patients</td>
<td>Number of patients 61 versus 62, No details on recommendations made or acted on</td>
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<td>UK</td>
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<td>Hospital inpatient interventions: older population with heart failure</td>
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<td>Lopez et al. [27]</td>
<td>134 heart failure patients (59.6% female) with a mean age of 75.3 years (SD 8.4) Patients with dementia were excluded</td>
<td>70 patients followed up for 12 months</td>
<td>Day of discharge from hospital with monthly telephone calls for the first 6 months followed by 2 monthly for the remaining 6 months On discharge a personal interview was performed by pharmacist, aimed at patient and caregiver. Explained characteristics of heart failure, diet education, information on drug therapy, value of the prescribed drugs and need to follow prescriptions detailed in the treatment sheet. Patients provided with phone number and pharmacist name to call</td>
<td>64 patients</td>
<td>(i) Number of patients 23 versus 31, (ii) Total admissions 39 versus 72, No details on recommendations made or acted on</td>
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<td>Spain</td>
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<td>Stewart et al. [28]</td>
<td>97 heart failure patients (79.7% female) with a mean age of 76 years (SD: 11)</td>
<td>39 patients followed by 6 months</td>
<td>Before discharge and 1 week post discharge Before discharge patients counselled by study nurse regarding treatment and reporting any signs of clinical deterioration. One week following discharge patients visited by study nurse and pharmacist, and an assessment of patients’ knowledge of their medications compliance performed. If appropriate, patients offered remedial counselling, a daily reminder routine, introduction of a weekly medication container, medical information and reminder card plus referral to community pharmacist for more regular review</td>
<td>48 patients</td>
<td>(i) Number of patients 24 versus 31, (ii) Total admissions 36 versus 63, No details on recommendations made or acted on</td>
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<td>Varma et al. [29]</td>
<td>Northern Ireland</td>
<td>83 elderly patients (55% female) with CHF with a mean age of 75.5 years (SD: 6.4)</td>
<td>42 patients followed up for 12 months</td>
<td>Follow-up provided by community pharmacist and physician</td>
<td>Number of patients: 12 versus 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Structured education about prescribed drugs and management of CHF symptoms provided by pharmacist. Printed booklet developed for education session for patients to take home. Daily monitoring cards provided. Physicians and community pharmacists contacted by phone to discuss the research project and self-monitoring programme</td>
<td>Total admissions: 14 versus 27</td>
</tr>
</tbody>
</table>

| Bouvy et al. [30] | Netherlands | 152 patients (38% female) with a mean age of 69.1 years (SD: 10.2) | 74 patients followed up for 6 months | Community pharmacists | Number of patients: 9 versus 3 | (i) RR: 3.16 (95% CI: 0.89, 11.23) |
|  |  |  |  | Initial review with monthly follow-up contact | Total admissions: 27 versus 23 | (ii) Rate ratio: 1.12 (95% CI: 0.56, 2.27) |
|  |  |  |  | A structured interview conducted by pharmacist on patient’s first visit to pharmacy. Computerised medication history used to discuss drug use, reasons for non-compliance such as possible adverse drug reactions and difficulties to integrate medication use in daily life, to reinforce medication compliance. Short report sent to the GP | No details on recommendations made or acted on |

CHF, congestive heart failure.
There was a significant reduction in unplanned hospital admissions demonstrated by pooling these three trials RR: 0.75 (95% CI: 0.59, 0.95). However, there was variation in the intensity of these three interventions, two of studies had 12-month follow-up [27, 29] and one had 6-month follow-up [28]. In addition, the Lopez and Stewart trials were rated as low risk of bias, but the Varma study showed a high risk of bias in addition to showing the greatest effect on admissions. It is important to point out though that the Varma study was published in 1999, when reporting standards were not as rigorous as they are now, and published protocols were rare. If only the data from the Lopez and Stewart studies were combined in a sensitivity analysis, a positive but non-significant effect was still seen (RR: 0.81, 95% CI: 0.62, 1.05). Overall, this effect must be interpreted with caution.

Of the three RCTs using hospital pharmacists, the Stewart trial suggests that costs were equitable between usual care and intervention group. The Lopez trial, however, shown that taking all costs into account, the intervention group was more cost-effective than the usual care group reducing hospital costs by 578 euros per patient. In the Varma study, the only statement relating to costs was ‘the average daily cost (1996–1997) on a general medical ward is much higher than the average cost of an emergency room visit (£175.38) and £35.27 respectively) therefore by having fewer hospital admissions its costs less to treat patients in the intervention group than the control group’. The remaining trial which utilised community pharmacists and therefore was not pooled with the other three RCTs utilised computerised medication history to discuss drug use and reasons for non-adherence, which was reported to the primary care physician [30]. No reduction in unplanned admissions was demonstrated by this trial RR 3.16 (95% CI: 0.89, 11.23).

Discussion

This systematic review examined the evidence from 20 RCTs, predominantly conducted in the UK and Europe, reported between 1994 and 2010, of pharmacist-led interventions and evaluating the effects on unplanned hospital admissions. The largest proportion of these (n = 16) focused on the older population [11–26] and four on the older population with heart failure [27–30]. There was no evidence of an effect on unplanned admissions from pharmacist-led interventions for the older population whether carried out by hospital or community pharmacists. These trials were assessed to be at a moderate risk of bias. However, in the three trials conducted by hospital pharmacists in the older population with heart failure, there was a 25% reduction in unplanned admissions and an absolute risk reduction of 19 cases per 100 [27–29]. In all three trials, hospital pharmacists provided education about heart failure prior to hospital discharge with continuing follow-up post discharge. However, the three trials were of different intensities and follow-ups. It is important to point out that one of these trials was assessed to be of a high risk of bias although this may in part be due to less rigorous reporting [29].
It is also important to acknowledge that the reducing hospital admissions or readmissions are not usually the main focus of the role of a pharmacist. Any pharmacist intervention is realistically only likely to affect hospitalisations that are related to drug therapy and in the management of complex older patients, medications may be only one of a

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Study or Subgroup</th>
<th>Intervention</th>
<th>Usual Care</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
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<tr>
<td>Inpatient only</td>
<td>Lisby 2010</td>
<td>11</td>
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<td>49</td>
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<tr>
<td></td>
<td>McMullin 1999</td>
<td>25</td>
<td>126</td>
<td>22</td>
<td>133</td>
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<td></td>
<td>Scullin 2007</td>
<td>141</td>
<td>371</td>
<td>172</td>
<td>391</td>
</tr>
<tr>
<td></td>
<td>Spinewine 2007</td>
<td>29</td>
<td>89</td>
<td>28</td>
<td>83</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td></td>
<td>636</td>
<td>656</td>
<td>46.0%</td>
<td>0.91 [0.79, 1.06]</td>
</tr>
<tr>
<td>Total events</td>
<td></td>
<td>206</td>
<td>233</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 1.57, df = 3 (P = 0.67); I² = 0%
Test for overall effect: Z = 1.18 (P = 0.24)

| Inpatient with follow up | Gillespie 2009 | 106 | 182 | 110 | 186 | 21.9% | 0.98 [0.83, 1.17] |
| | Lipton 1994 | 126 | 350 | 118 | 386 | 23.5% | 1.09 [0.89, 1.33] |
| | Nazareth 2001 | 38 | 181 | 43 | 181 | 8.6% | 0.88 [0.60, 1.30] |
| Subtotal (95% CI) | | 713 | 723 | 54.0% | 1.01 [0.89, 1.15] |
| Total events | | 270 | 271 | | | |

Heterogeneity: Chi² = 1.04, df = 2 (P = 0.59); I² = 0%
Test for overall effect: Z = 0.19 (P = 0.85)

Total (95% CI) | 1349 | 1379 | 100.0% | 0.97 [0.88, 1.07] |
| Total events | 476 | 504 | | |

Heterogeneity: Chi² = 3.83, df = 6 (P = 0.70); I² = 0%
Test for overall effect: Z = 0.67 (P = 0.50)
Test for subgroup differences: Chi² = 1.05, df = 1 (P = 0.31), I² = 4.4%

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**Figure 3.** Forest plots for medication reviews in the older population. (a) Hospital pharmacists. (b) Community pharmacists.
number of problems areas resulting in the breakdown of care in the community. Previous research has shown that the most frequent benefits resulting from pharmacist reviews are the recommendation of monitoring, removing unnecessary drugs from repeat prescriptions and providing advice on compliance and the prevention of potential adverse effects [19, 20, 26]. For example, a recent RCT showed that a pharmacist-led information technology-based intervention in primary care was more effective than simple feedback in reducing the number of patients at risk of measures related to hazardous prescribing and inadequate blood-test monitoring of medicines 6 months after the intervention [31].

Three previous reviews have been published assessing pharmacist-led interventions and focusing on primary care-based clinical pharmacy and the older population [6–8]. However, the most recent was published in 2007 [7]. Two reviews considered admissions, but none reported on unplanned or unscheduled hospital admissions. Royal et al. [6] and Holland et al. [7] assessed the effect on all-cause hospital admission. Royal et al. [6] found relatively weak evidence to indicate that pharmacist-led medication reviews in primary care were effective at reducing all-cause hospital admissions. While Holland et al. [7] concluded that pharmacist-led medication reviews did not have any effect on reducing mortality or all-cause hospital admission in older people and cannot be assumed to provide substantial clinical benefit. This review adds to these findings that pharmacist-led interventions, whether community or hospital based, do not affect unplanned hospital admissions in older people. The review by Kaboli et al. [8] focused on outcomes other than hospital admissions and concluded that the addition of clinical pharmacist services in the care of inpatients generally resulted in improved care, with no evidence of harm.

The strengths of this systematic review were the comprehensive search strategy employed without limitations which searched all relevant databases. The search strategy was supplemented by checking trial and systematic review references, searches of relevant websites and contacting authors. Where additional data were required for inclusion trials, authors were contacted. In addition, a post hoc search in Medline was made in February 2013 upon completion of the paper to ensure no new studies had been published during this time. It yielded 563 papers of which six were potentially eligible after screening titles and abstracts. However, full text revealed that none were suitable for inclusion due to non-RCT (2), protocol of a RCT (2), and having no relevant outcomes, and not from an OECD country.

The primary outcome of this review was unplanned admissions and did not take into account the effects these interventions may have had on other outcomes such as medication-related problems, adherence, quality of life and mortality which have been evaluated previously [7, 8].

Publication bias is an important potential source of bias in systematic reviews [10].

Although we made considerable effort to locate unpublished trials, a small number may have been omitted from the review. The identification of both positive and negative trials from our search makes it unlikely that further high-quality trials would remain unpublished.

Pharmacists have responsibility for ensuring the safe, effective and rational use of medicines [2]. Policy-makers have been encouraging pharmacists to play an increased role in improving health and reducing health inequalities [5, 19]. Patient’s beliefs and views about medicines are a key influence on when, how and whether they take their medication [32]. Attempts to address medication-related problems include improving concordance and adherence, reconciliation between medical records and actual use and medication reviews in hospital, outpatient, community and home-based settings [33]. This systematic review demonstrates a lack of evidence to suggest that pharmacist-led interventions have a benefit on the reduction of unplanned hospital admissions in the older population with the possible exception of heart failure. The 25% reduction in unplanned admissions from the three published RCTs for older people with heart failure is promising; however, this requires confirmation in further high-quality evaluations.

Key points

- Pharmacist review effect on unplanned hospital admissions.
- Systematic review.
- Meta-analysis of data from the general older population and older patients with heart failure.

Supplementary data

Supplementary data mentioned in the text are available to subscribers in Age and Ageing online.

Conflicts of interest

None declared.

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