Identifying the Optimal Role for Pharmacists in Care Transitions: A Systematic Review

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ABSTRACT

BACKGROUND: A transition from one health care setting to another increases the risk of medication errors. Several strategies have been applied to improve care transitions and reduce adverse clinical outcomes. Pharmacist intervention during and after hospitalization has been frequently studied and show a variable effect on these outcomes.

OBJECTIVE: To identify the components of pharmacist intervention that improve clinical outcomes during care transitions.

METHODS: MEDLINE, EMBASE, International Pharmaceutical Abstracts, and Web of Science databases were searched for randomized controlled trials (RCTs) that studied pharmacist intervention with regard to hospitalization. Two reviewers independently screened all references published from inception to November 2014, extracted data, and assessed risk of bias.

RESULTS: A total of 30 studies met the inclusion criteria. A model was created to categorize and cluster components of pharmacist intervention. The average number of components deployed, stages of hospitalization covered, and intervention targets were equally distributed between effective and ineffective studies. A best evidence synthesis of 15 studies revealed strong evidence for a clinical medication review in multifaceted programs (5 effective vs. 0 ineffective studies). Conflicting evidence was found for an isolated postdischarge intervention, admission medication reconciliation, combining postdischarge interventions with in-hospital interventions, and covering of multiple stages. Closely collaborating with other health care providers enhanced the effectiveness.

CONCLUSIONS: Although there is a need for well-designed and well-reported RCTs, the study heterogeneity enabled a best evidence synthesis to elucidate effective components of pharmacist intervention. In isolated postdischarge intervention programs, evidence tends towards collaborating with nurses and tailoring to individual patient needs. In multifaceted intervention programs, performing medication reconciliation alone is insufficient in reducing postdischarge clinical outcomes and should be combined with active patient counseling and a clinical medication review. Furthermore, close collaboration between pharmacists and physicians is beneficial. Finally, it is important to secure continuity of care by integrating pharmacists in these multifaceted programs across health care settings. Ultimately, pharmacists need to know patient clinical background and previous hospital experience.

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What is already known about this subject

- Transitions between health care settings increase the risk of medication errors, which can result in adverse drug events, prolonged hospital stay, early readmissions, and use of other health care resources.
- Pharmacist intervention during and after hospitalization have been frequently studied, albeit with varied effects on clinical outcomes.
- Several systematic reviews have been performed studying care transition programs, although none have done so by separating pharmacist intervention components from continuity of care programs.

What this study adds

- Our model systematically categorized components of pharmacist intervention in care transition programs. Study heterogeneity enabled a best evidence synthesis to elucidate effective components.
- This review revealed that multifaceted programs should combine medication reconciliation with active patient counseling and a clinical medication review. Care continuity can be secured by integrating pharmacists across settings and providing them with patients' clinical background.
- Collaborating with other health care professionals is crucial to increase the effectiveness of pharmacist intervention.

A transition from one health care setting to another increases the risk of medication errors. Medication errors have been particularly attributed to poor communication or loss of important information.[1] These errors can result in clinically relevant outcomes such as adverse drug events (ADEs), increased duration of hospital stay, early readmissions after discharge, and use of other health care resources.[2] Although ADEs generally are the most invasive type of drug-related problems (DRPs), other DRPs may also result in patient harm, which then results in unplanned hospital readmissions.[3]

Numerous strategies have been applied to reduce the number of ADEs and (drug-related) readmissions by involving various health care professionals such as nurses and pharmacists.[4-7] Because of the likely link between DRPs and adverse

clinical outcomes, pharmacists may be the preferred health care provider to intervene and reduce the risks involved in care transitions, a view endorsed by 2 Institute of Medicine reports.[8,9] Pharmacist intervention during and after hospitalization has been studied, albeit with varying effects on clinical outcomes. Some studies have shown significant reduction in drug-related readmissions, whereas others have shown improved surrogate outcomes (e.g., medication appropriateness or knowledge) but lacked significant impact on readmissions or had no effect at all.[10-13] Other studies have revealed a significant reduction in readmission rates but did not use a randomized study design.[14,15]

Several systematic reviews have studied care transition programs.[2,16-29] However, these reviews focused either on a specific intervention component (e.g., hospital-based medication reconciliation); an isolated health care setting (e.g., an inpatient care setting); a specific high-risk population (e.g., heart failure patients); included only 1 outcome (e.g., readmissions); or did not specifically target pharmacist intervention. Finally, most reviews lacked an extensive description of the intervention components deployed in the included studies.

The purpose of this systematic review was to focus specifically on unraveling the components of pharmacist intervention from continuity of care programs that improved clinical outcomes.

Methods

Search Strategy

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Appendix A, available in online article).[30] Three electronic databases were searched (MEDLINE, EMBASE, and International Pharmaceutical Abstracts [IPA]) from inception to November 2014. Randomized controlled trials (RCTs) investigating interventions with regard to adult hospitalization and discharge with a proactive role for a pharmacist of any type (e.g., hospital, community, clinical) were identified (Appendix B, available in online article). The search strategy was designed in MEDLINE using the following medical subject headings and text words: *patient education, counseling, medication therapy management, medication errors/prevention and control, medication reconciliation, continuity of patient care, patient care planning, aftercare, house calls,* and *drug utilization review.* Synonymous terms combined with words for *hospital admission* and *pharmacist profession* were also used (see Appendix C for detailed search terms, available in online article). Only studies in English were included. The search strategy was further refined and validated by indexing known relevant articles. For EMBASE and IPA, search terms were adapted according to the capabilities of these particular databases. Reference lists of all included trials, previous systematic reviews, and the citation indexing service Web of Science were checked manually for additional relevant publications.

Review Process

The reference management software RefWorks was used to manage all citations (ProQuest LLC, Ann Arbor, MI). First, each reference title was screened independently by 2 reviewers (authors Ensing and Stuijt) for eligibility against the agreed inclusion and exclusion criteria (Appendix B). Next, all included abstracts were screened. Finally, the resulting full-text copies of all studies considered to be of potential relevance were retrieved and screened similarly. Inter-rater agreement was calculated, and disagreement between the reviewers was resolved through discussion.

Data Collection

Data from included trials were extracted into MS Excel 2007 (Microsoft Corporation, Redmond, WA) by 1 of the 2 initial reviewers and independently checked by a second reviewer from among the authors of this study. The following characteristics of each study were retrieved: general information (first author, year of publication); study design (multicenter or single center, hospital and ward type); patient characteristics (sample size, gender, age, number of medications, health state); method (inclusion and exclusion criteria, usual care, pharmacist intervention components, coinvolved health care provider [HCP]); study outcomes; and conclusions. Appendix D (available in online article) contains a complete list of extracted parameters.

Quality Assessment of Individual Studies

The methodological quality of the studies was independently assessed by the 2 reviewers according to the Cochrane risk of bias tool.[31] This is a domain-based evaluation in which critical assessments are made over 7 separate domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessors, incomplete outcome data, selective reporting, and other sources of bias. The nature of the studied interventions implicated unblinded personnel and participants, resulting in a high risk of performance bias for all included studies and a maximum score of 6 bias-free domains. Other domains were scored as high, low, or unclear risk of bias. Disagreement was resolved through discussion.

Data Synthesis and Analysis

The included studies were heterogeneous regarding the intervention components, included populations, coinvolved HCPs, and outcomes. Therefore, statistical aggregation of findings was deemed inappropriate, and a qualitative analysis was performed.[32,33] The following steps were undertaken to systematically categorize the results:

1. Only pharmacist intervention components reported in the original manuscript were used.
2. All pharmacist intervention components were screened and categorized independently by the 2 author/reviewers,

creating a pharmacist intervention model (Table 1) covering all components.

3. The 15 intervention components included in the pharmacist intervention model were structured by applying 3 types of clustering (Table 1):
   a. *Target:* patient-aimed or HCP-aimed interventions.
   b. *Nature:* pharmacist professional care or administrative interventions. Professional care interventions included all services using pharmacists' skills and knowledge for an active role in patient health care. Administrative interventions comprised providing and handling of documents, for example.
   c. *Stage:* intervention performed at admission, during admission, at discharge, postdischarge, or stage-independent.
4. All outcomes were extracted, and—if not supplied by the respective study authors—effectiveness rates were calculated. Studies were categorized as "effective" in cases where at least 1 of the predefined outcomes was statistically significant (inclusion criteria, Appendix B). In case of a mixed effect (e.g., a significant increase in ADEs and a significant decrease in emergency department visits), the following priority of clinical relevance was applied: (a) mortality, (b) readmissions, (c) emergency department visits, and (d) ADEs, with the latter being the least relevant. Statistical significance was set at $P < 0.05$.
5. Average numbers of intervention components according to the clusters previously mentioned were compared between effective and ineffective studies. Data were checked for normality, and either an independent t-test or Mann-Whitney U test was performed to detect significant differences ($P < 0.05$).

Finally, a best evidence synthesis was conducted according to the framework proposed by Treadwell et al. (2012).[34] Since our review included only RCTs, a stringent threshold in methodological quality was used to define the "best evidence set" by including studies with 5 or more bias-free domains. To attribute various levels of evidence to the effectiveness of the pharmacist intervention components, all reported study parameters ([combinations of] interventions, intervention stages, coinvolved HCPs, pharmacist type, setting characteristics) were taken into account. Evidence levels were based on van Tulder et al. (2003)[35] and are as follows: (a) *Strong*—consistent findings among multiple high quality RCTs; (b) *Moderate*—findings in 1 high quality RCT; and (c) *Conflicting*—inconsistent findings among multiple high quality RCTs. Since only RCTs were included, the levels *Limited evidence* and *No evidence* were not applicable.

Results

Study Selection

The searches identified 3,084 records, which resulted in 2,619 nonduplicate items. Thirty papers met the inclusion criteria and were included in this systematic review (Figure 1).[6,10-13,36-60] The observed similarity between the 2 author/reviewers for full-text screening was 94% (inter-rater agreement $\kappa = 0.87$, Appendix E, available in online article), and all disagreements were resolved through discussion. Reasons for exclusion at this stage are given in Appendix F (available in online article).

Study Characteristics

The 30 included studies covered all Western continents: North America (n = 15), Europe (n = 10), and Australia (n = 5). Just over half of the studies (n = 17) were conducted in an academic, teaching, or tertiary referral hospital (Table 2). Eleven studies implemented a hospital-wide intervention program, whereas others focused on patients in specific wards (mainly internal or general medicine, n = 11). The number of included patients varied considerably among the studies (range = 34-936). Subjects in both arms of these studies were generally well matched. Eighteen studies included patients with predefined health conditions or other high-risk factors. These were mainly chronic heart failure (n = 8) or acute hospital admission (n = 5; Table 2).

Quality Assessment of Individual Studies

Of the total 180 domains, 19% (n = 34) were scored differently by the 2 reviewers and resolved through discussion. Eight studies scored low risk for bias in all 6 domains (Appendix G, available in online article).[13,39-41,48,54,55,59] Of the items in the selection bias, detection bias, attrition bias, and reporting bias domains, 11% could not be assessed due to insufficient data in the original studies. Five studies were considered at high risk for other bias; all had contamination bias because the same pharmacist took care of the intervention and control groups.[10,11,45,56,58] Finally, there was an unclear risk of other bias with an unclear effect on study outcomes in 10 studies: possible contamination bias,[12,44,49,50] possible compliance bias,[36,42,57] possible recall bias of participants,[51,60] and baseline differences with lack of power for adequate conclusions.[37]

Results of Individual Studies: Pharmacist Interventions and Outcome Measurements

The overall number of intervention components for a specific outcome is presented in Appendix H (available in online article). This cross-tab illustrates, together with the heterogeneity in studied populations and coinvolved HCPs, the dissimilarity of included studies (Table 2 and, for background data, Appendix I, available in online article).

Patient-centered follow-up is the most deployed intervention (n = 19), followed by HCP-centered follow-up (n = 14; Appendix J, available in online article). Other frequently used

TABLE 1 Pharmacist Intervention Model, with 3 Types of Clustering: Intervention Target, Intervention Nature, and Stage

Intervention Number	Intervention Category	Clarification	Target	Nature	Stage
1	Admission reconciliation	• All activities that led to assembling an accurate medication list, including a check for appropriateness of prescribing and documentation of changes.	HCP	A	OA
2	Patient counseling on admission	• Actively incorporating the patient as a source (or recipient) of information. • Patient counseling was not restricted to a certain stage, therefore, this intervention was split to allow assignment to all stages (intervention numbers 1, 5, and 7).	Pt	P	OA
3	Pharmacist is part of medical team	• Pharmacist was an active member of the medical team, e.g., by participating in ward rounds.	HCP	P	DA
4	Medication review	• According to Hatah et al.,[64] medication review can be classified into 4 levels of comprehensiveness: (1) prescription review, (2) adherence support review (with patient present), (3) clinical review, and (4) clinical review with prescribing. The latter 2 are conducted in close collaboration with physicians. • All levels were clustered in the PIM, but to prevent overclassification of lower levels, the accompanying number is indicated in the results.	HCP	P	DA
5	Patient counseling during admission	• See intervention 2.	Pt	P	DA
6	Discharge reconciliation	• See intervention 1.	HCP	A	AD
7	Patient counseling at discharge	• See intervention 2.	Pt	P	AD
8	Supplying patient with discharge letter	• Providing the patient with a copy of the discharge letter to facilitate medication management postdischarge.	Pt	A	AD
9	Transmission to next HCP	• Transmission of an updated and verified medication list to next health care provider.	HCP	A	AD
10	Patient-centered follow-up	• Postdischarge follow-up classification was based on intervention target. • The subdivision in house calls (H), clinic visits (C), and telephone calls (T) is indicated in the results. • Patient-centered follow-up comprises adherence counseling, for example.	Pt	P	PD
11	HCP-centered follow-up	• See intervention 10. • HCP-centered follow-up consists of reporting drug-related problems to general practitioner, for example.	HCP	P	PD
12	Extra postdischarge follow-up	• Additional postdischarge follow-up to review progress and/or reinforce initial advice.	Pt	P	PD
13[a]	Tailored interventions	• Interventions were tailored to individual patient's needs (e.g., cognition or low-literacy skills).	Pt	P	SI
14[a]	Provision of adherence aids	• Supplying a pill box or a daily reminder routine, for example.	Pt	A	SI
15[a]	Dispensing or logistics aids	• Disposing of out-of-use or out-of-date medication, for example.	Pt	A	SI

[a]*Interventions 13-15 were not bound to a certain stage and were therefore scored as stage independent.*

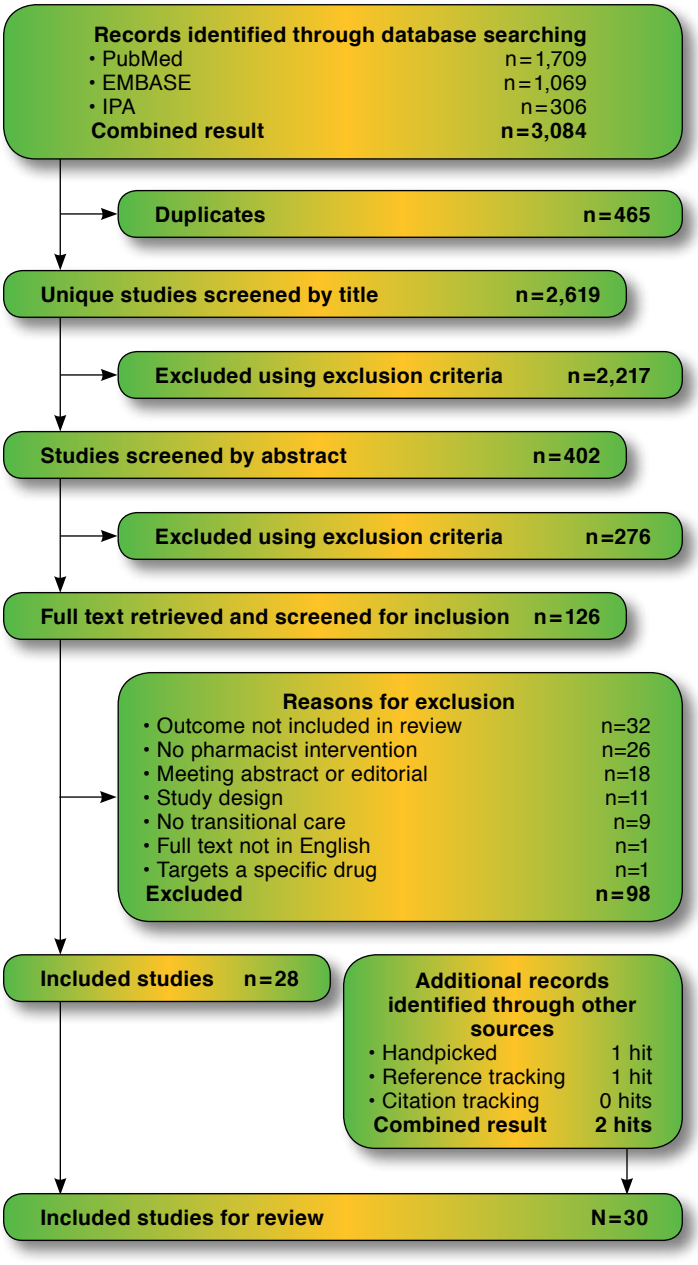
A = administrative; AD = at discharge; DA = during admission; HCP = health care provider; OA = on admission; P = professional; PD = postdischarge; PIM = pharmacist intervention model; Pt = patient; SI = stage independent.

interventions were medication review during admission (n = 13), patient counseling at discharge (n = 13), and admission reconciliation (n = 11; Appendix J). Most studies measured readmissions (n = 24), followed by mortality (n = 15), emergency department visits (n = 10), and ADEs (n = 4; Table 2). Only 2 studies reported a composite outcome measurement (composite readmission/emergency department visits and composite readmission/emergency department visits/mortality, respectively) impeding analysis of the individual outcomes.[12,42]

Results of Individual Studies: Effectiveness of Interventions

Study effects are shown in Table 2. All 30 studies showed a consistent effect on the outcomes included in this review. One study reported a significant increase in hospital readmissions at 6 months postdischarge.[39] The average number of different pharmacist intervention components deployed in effective versus ineffective studies was approximately the same, 4.3 versus 5.1, respectively, as well as average patient-aimed (2.4 vs. 2.9), HCP-aimed (1.9 vs. 2.2), professional (2.9 vs. 3.0), and administrative intervention components (1.3 vs. 2.1). Finally,

FIGURE 1 Summary of Evidence Search and Selection



IPA = International Pharmaceutical Abstracts.

average-covered stages (1.9 vs. 2.1) and stage-independent interventions (0.6 vs. 0.6) were equally distributed, resulting in seemingly corresponding study characteristics regarding the deployed pharmacist interventions. All data were non-normally distributed, and none of these differences were statistically significant ($P > 0.05$).

Best Evidence Synthesis

The cutoff point of ≥5 bias-free domains yielded 15 studies, 9 effective and 6 ineffective, for the best evidence synthesis (Table 3).[10,13,39-41,43,45,48,50-55,59] Levels of evidence were attributed to individual intervention components on improving the selected clinical outcomes.

Five studies, 3 effective and 2 ineffective, investigated the effect of isolated postdischarge intervention components indicating conflicting evidence.[39-41,54,55] The studies' characteristics varied, since all 3 effective studies incorporated active nurse involvement either during the follow-up intervention or at hospital discharge. Furthermore, effective studies implemented individual patient tailoring, whereas ineffective studies had 1 or more additional follow-up contact moments.

Ten studies covered 1 or more hospital stages or combined in-hospital with postdischarge intervention components. By analyzing the individual components of these multifaceted interventions, different best evidence synthesis levels could be assigned. There is strong evidence for active pharmacist involvement during admission by performing a level 3 medication review. This level also requires active physician involvement (Table 3). Five effective studies incorporated this intervention component, compared with none of the ineffective studies.[10,50-53] In 2 out of these 5 effective studies, the pharmacist was also part of the multidisciplinary medical team.[10,50] All other intervention components revealed conflicting evidence. Five studies (3 effective and 2 ineffective) incorporated medication reconciliation on admission.[10,13,52,53,59] Two of the effective studies combined reconciliation with patient counseling on admission.[10,53] Five studies (3 effective and 2 ineffective) covered 3 or more stages from hospital admission to postdischarge follow-up.[10,13,51,53,59] Finally, 7 studies (3 effective and 4 ineffective) combined a postdischarge intervention with 1 or more in-hospital intervention.[10,13,43,45,48,51,59] The postdischarge intervention components varied mainly in thoroughness.

Discussion

All included studies varied regarding the type and moment of intervention, studied population, involvement of other health care providers, and selected outcomes. This variability is reflected in the clinical outcomes of these studies. Although this heterogeneity resulted in inconclusiveness of our predefined clustering to elucidate the most effective intervention components, the heterogeneity also enabled a best evidence synthesis. This synthesis suggests that for an isolated postdischarge program, pharmacists are most likely to contribute to improved patient outcomes by closely collaborating with nurses. Moreover, in multifaceted programs, pharmacists have additional value by performing a clinical medication review in addition to patient-involved medication reconciliation followed up by a thorough postdischarge intervention. Finally, the best evidence synthesis suggests that these pharmacist

TABLE 2 Characteristics of Studies Included in Systematic Review

Author/Date	Setting (Country/Ward/Hospital Type/Sample Size + High-Risk Selection, If Applicable)	Outcome[a]	Time	Effect (%)
Al-Rashed et al., 2002[58]	GBR/elderly ward/general hospital/83 patients	*Readmissions*	*15-22 days*	↓*62*
		Readmissions	*3 months*	↓*80*
Barker et al., 2012[37]	AUS/all wards/teaching hospital/114 CHF patients	Mortality	6 months	↑41
		Readmissions	6 months	↑18
Bolas et al., 2004[38]	GBR/medical admission ward/general hospital/162 acutely admitted patients	Readmissions (emergency)	3 months	NR
Dudas et al., 2001[36]	USA/general medicine ward/academic hospital/145 patients	Readmissions	30 days	↓40
		ED visits	*30 days*	↓*58*
Englander et al., 2014[6]	USA/general medicine & cardiology wards/ academic hospital/382 patients	*Mortality*	*30 days*	↓*100*
		Readmissions	30 days	↓11
		ED visits	30 days	↓24
Farris et al, 2014[59]	USA/a general medicine, family medicine, cardiology, or orthopedics ward/academic hospital/936 patients with a predefined chronic condition	Readmissions (inpatient & outpatient intervention)	30 days	↑14
		Readmissions (inpatient intervention)	30 days	↓8
		Readmissions (inpatient & outpatient intervention)	90 days	↑9
		Readmissions (inpatient intervention)	90 days	↑9
		ED visits (inpatient & outpatient intervention)	30 days	↓24
		ED visits (inpatient intervention)	30 days	↓7
		ED visits (inpatient & outpatient intervention)	90 days	↓7
		ED visits (inpatient intervention)	90 days	↓13
		ADEs (inpatient & outpatient intervention)	on admission	↓15
		ADEs (inpatient & outpatient intervention)	at discharge	↑36
		ADEs (inpatient intervention)	90 days	↓8
		ADEs (inpatient & outpatient intervention)	90 days	↓5
Gillespie et al., 2009[10]	SWE/internal medicine ward/academic hospital/368 acutely admitted patients	Mortality	12 months	↑3
		Readmissions	12 months	↓3
		Readmissions (drug related)	*12 months*	↓*80*
		ED visits	*12 months*	↓*47*
		Composite RE	*12 months*	↓*16*
Gwadry-Sridhar et al., 2005[12]	CAN/acute medical & surgical wards/teaching hospital/134 CHF patients	Composite REM	12 months	↓10
Hawes et al., 2014[60]	USA/family medicine ward/academic hospital/61 patients with a predefined chronic condition	*Readmissions (intention to treat)*	*30 days*	↓*100*
		Readmissions (per protocol)	*30 days*	↓*100*
		ED visits (intention to treat)	*30 days*	↓*100*
		ED visits (per protocol)	*30 days*	↓*100*
		Composite RE (intention to treat)	*30 days*	↓*100*
		Composite RE (per protocol)	*30 days*	↓*100*
Holland et al., 2005[39]	GBR/all wards/several general hospitals/829 acutely admitted patients	Mortality	6 months	↓22
		Readmissions (emergency)	*6 months*	↑*31*
Holland et al., 2007[40]	GBR/all wards/3 general hospitals/291 acutely admitted CHF patients	Mortality	6 months	↑25
		Readmissions	6 months	↑20
Jack et al., 2009[41]	USA/all wards/academic hospital/738 patients	Readmissions	30 days	↓28
		ED visits	*30 days*	↓*32*
		Composite RE	*30 days*	↓*30*
Koehler et al., 2009[42]	USA/hospital-medicine ward/academic hospital/ 41 patients more than 3 chronic conditions	*Composite RE*	*3 months*	↓*74*
		Composite RE	6 months	↑300
Kripalani et al., 2012[13]	USA/cardiology ward/2 academic hospitals/851 CHF patients	ADEs (preventable)	30 days	↑8
		ADEs (potential)	30 days	↓20
Lipton and Bird, 1994[43]	USA/all wards (except psychiatry)/general hospital/706 patients	Readmissions (emergency)	1 months	NR
		Readmissions (emergency)	3 months	NR
		Readmissions (emergency)	6 months	NR
Lisby et al., 2010[44]	DNK/internal medicine ward/general hospital/99 acutely admitted patients	Mortality	3 months	↑60
		Readmissions	3 months	↓20
		ED visits	3 months	↔0

TABLE 2 Characteristics of Studies Included in Systematic Review *(continued)*

Author/Date	Setting (Country/Ward/Hospital Type/Sample Size + High-Risk Selection, If Applicable)	Outcome[a]	Time	Effect (%)
López Cabezas et al., 2006[45]	ESP/cardiology & internal medicine wards/2 general hospitals/134 CHF patients	Mortality	2 months	↓83
		Mortality	6 months	↓50
		Mortality	*12 months*	*↓53*
		Readmissions	*2 months*	*↓68*
		Readmissions	*6 months*	*↓57*
		Readmissions	12 months	↓50
Makowsky et al., 2009[46]	CAN/acute internal medicine & family medicine wards/3 teaching hospitals/451 patients with a predefined chronic condition	*Readmissions*	*3 months*	*↓20*
		Readmissions	6 months	↓10
Naunton et al., 2003[47]	AUS/all medical wards/teaching hospital/121 patients with more than 2 medication-requiring chronic conditions	Mortality	3 months	↓38
		Readmissions	*3 months*	*↓38*
Nazareth et al., 2001[48]	GBR/geriatric medicine ward/4 general hospitals/347 patients	Mortality	3 months	↑116
		Mortality	6 months	↑28
		Readmissions	3 months	↔0
		Readmissions	6 months	↓2
Rainville, 1999[49]	USA/all wards/tertiary hospital/34 CHF patients	*Readmissions (HF related)*	*12 months*	*↓60*
		Composite REM (HF related)	*12 months*	*↓64*
Schmader et al., 2004[50]	USA/all wards/11 Veterans Affairs hospitals/834 patients meeting frailty criteria	*ADEs (all, inpatient intervention)*	*at discharge*	*↑222*
		ADEs (serious, inpatient intervention)	at discharge	↑80
		ADEs (all, inpatient intervention)	12 months	↓18
		ADEs (serious, inpatient intervention)	12 months	↓19
		ADEs (all, outpatient intervention)	12 months	↓1
		ADEs (serious, outpatient intervention)	*12 months*	*↓37*
Schnipper et al., 2006[51]	USA/general medicine ward/teaching hospital/ 152 patients	Composite RE	30 days	↔0
		Composite RE (drug related)	30 days	↓50
		Composite RE (preventable drug related)	*30 days*	*↓88*
		ADEs (preventable)	*30 days*	*↓88*
Schnipper et al., 2009[52]	USA/general medicine ward/2 general hospitals/ 322 patients	Composite RE	30 days	↓17
		ADEs (potential)	*at discharge*	*↓26*
Scullin et al., 2007[53]	GBR/2 medical wards/3 general hospitals/762 patients	Mortality	12 months	↓8
		Readmissions	*12 months*	*↓17*
Spinewine et al., 2007[11]	BEL/geriatric medicine ward/academic hospital/ 186 patients	Mortality	12 months	↓25
		Readmissions	12 months	↓3
		ED visits	12 months	↓34
Stewart et al., 1998[55]	AUS/all wards/tertiary hospital/762 patients	*Mortality*	*6 months*	*↓59*
		Readmissions	*6 months*	*↓22*
		ED visits	*6 months*	*↓25*
		Composite RM	*6 months*	*↓29*
Stewart et al., 1998[54]	AUS/all wards/tertiary hospital/97 CHF patients	Mortality	6 months	↓50
		Readmissions	6 months	↓23
		ED visits	*6 months*	*↓45*
		Composite RM	*6 months*	*↓43*
Stowasser et al., 2002[56]	AUS/all acute wards & orthopedics ward/2 general hospitals/240 patients	Mortality	30 days	↓25
		Readmissions	30 days	↓74
		Readmissions (emergency)	30 days	↓38
Triller et al., 2007[57]	USA/all wards/2 general hospitals/154 CHF patients	Mortality	6 months	↑21
		Readmissions	6 months	↓9

Note: Italicized entries indicate P < 0.05.

[a]*Outcomes reported as all-cause if not stated otherwise.*

ADEs = adverse drug events; AUS = Australia; BEL = Belgium; CAN = Canada; CHF = congestive heart failure; DNK = Denmark; ED = emergency department; ESP = Spain; GBR = United Kingdom; HCP = health care provider; HF = heart failure; RE = readmissions and ED visits; REM = readmissions, ED visits, and mortality; NR = not reported; RM = readmissions and mortality; SWE = Sweden; USA = United States of America.

TABLE 3 Best Evidence Synthesis: Effective (Upper-Part) Versus Ineffective (Lower-Part) Studies, Sorted by Bias-Free Domains

Study Characteristics			Pharmacist Intervention														
Author/Date	Bias-Free Domains	Coinvolved Health Care Provider	1	2	3	4[a]	5	6	7	8	9	10[b]	11	12	13	14	15
Jack et al., 2009[41]	6	N: coordination, counseling PCP: act on drug-related recommendations (PD)										T	●				
Stewart et al., 1998[54]	6	N: counseling, risk assessment, and referral										H	●		●	●	
Stewart et al., 1998[55]	6	N: counseling, risk assessment, and referral										H	●		●	●	
Gillespie et al., 2009[10]	5	S: act on drug-related recommendations (DA)	●	●	●	3	●		●	●	●	T			●		
López Cabezas et al., 2006[45]	5	None							●			T		●			
Schmader et al., 2004[50]	5	S: act on drug-related recommendations (DA)			●	3											
Schnipper et al., 2006[51]	5	S: act on drug-related recommendations (DA) PCP: act on drug-related recommendations (PD)				3		●	●			T	●				
Schnipper et al., 2009[52]	5	S: reconciliation, act on drug-related recommendations (DA) N: counseling	●			3											
Scullin et al., 2007[53]	5	S: act on drug-related recommendations (DA)	●	●		3	●	●	●	●	●				●		●
Farris et al., 2014[59]	6	PCP: act on drug-related recommendations (PD)	●				●	●	●	●	●	T	●	●		●	
Holland et al., 2005[39]	6	PCP: act on drug-related recommendations (PD)										H	●	●			●
Holland et al., 2007[40]	6	PCP: act on drug-related recommendations (PD)										H	●	●			●
Kripalani et al., 2012[13]	6	SW: coordination PCP: act on drug-related recommendations (PD)	●			2	●		●	●		T	●		●	●	
Nazareth et al., 2001[48]	6	PCP: act on drug-related recommendations (PD)						●	●	●	●	H	●		●		
Lipton and Bird, 1994[43]	5	PCP: act on drug-related recommendations (PD)						●	●			T	●	●			

[a]*Medication review levels: 2=adherence support review (with patient present), 3=clinical review.*
[b]*H=home visit; T=telephone call.*
DA=during admission; N=nurse; PCP=primary care physician; PD=postdischarge; S=specialist; SW=social worker.

interventions are especially effective when performed in close collaboration with physicians.

The conflicting evidence regarding studies investigating an isolated postdischarge intervention possibly originates from the variances in study conditions.[39-41,54,55] As mentioned earlier, all 3 effective studies involved a pharmacist's follow-up in close collaboration with a nurse. In 2 studies, this involvement was realized by performing a home-based follow-up as a pharmacist-nurse team.[54,55] In those cases, the nurse focused on detecting any clinical deterioration, whereas the pharmacist focused mainly on adherence counseling and adequate monitoring by caregivers. If necessary, both HCPs deployed a subsequent referral to either the general practitioner or community pharmacist, respectively. The third study brought nurses into action to coordinate the discharge plan with the hospital team and educate and prepare patients for discharge.[41] These results indicate the need for a multidisciplinary intervention, which is in agreement with earlier findings.[19] Next, tailoring the intervention, for instance by assessing patient knowledge of the prescribed medications and compliance, was utilized in all effective studies (in Jack et al., 2009,[41] nurses used tailored intervention during hospital discharge). This practice is in contrast with the ineffective studies, which had the more general approach of offering medication boxes to every patient involved, for example.[39,40,61] The need for tailoring intervention to patient needs is further illustrated by the ineffective studies,

which deployed additional follow-up visits to reinforce original advice. Although in itself this might be a valuable intervention component, it should possibly be tailored to specific patient needs or population to optimize its efficacy. Finally, effective studies deployed a pharmacist from the involved hospital, whereas ineffective studies deployed an external research pharmacist who was neither familiar with the patients' home situations nor the previous hospital stays. Hence, as hospital discharge is well known to be confusing and distressing,[62,63] this might increase the risk of discontinuity of care.

Regarding the multifaceted programs, several implications for daily practice can be extracted. Although individual effects of multifaceted interventions are difficult to determine, the best evidence synthesis imposed strong evidence for the effectiveness of medication review during hospital admission. Six multifaceted intervention programs incorporated this intervention component, but the level of assessing medication appropriateness varies between studies.[10,13,50-53,64] The 5 effective studies performed a rigorous clinical medication review (level 3) as compared with 1 ineffective study that performed an adherence support review (level 2). A level 3 review aimed at optimization of pharmacotherapy with access to clinical notes enables pharmacists to address the patients' use of medications in the context of their clinical conditions. Furthermore, a level 3 medication review during hospital admission requires a close collaboration with the responsible physician. Since only the effective studies incorporated this rigorous review, the beneficial effect might also be attributed to the multidisciplinary collaboration between pharmacists and physicians.

Several multifaceted intervention programs deployed medication reconciliation on admission but differed in setting by active patient involvement.[10,13,52,53,59] A recent report by the Agency for Healthcare Research and Quality (AHRQ) evaluated the role of pharmacists during care transition programs.[65] This report recommends medication reconciliation during care transition to minimize risks. However, to obtain a best possible medication history, medication reconciliation needs to be supplemented with a structured patient interview.[16] All 3 effective studies included this intervention, either by the pharmacist or by the attending physician, in contrast to the 2 ineffective studies that did not include the interview.[13,59] This indicates that a structured patient interview needs to be part of admission reconciliation, but it does not necessarily need to be conducted by a pharmacist.

Kwan et al. (2013) suggested that performing medication reconciliation alone is not sufficient to reduce postdischarge clinical outcomes (e.g., hospital readmission), since it needs to be combined with other interventions aimed at care transition improvement.[16] By incorporating an extensive combination of pharmacist interventions in hospital and primary health care settings, continuity of care can be secured.[24] In this review, 7 studies combined a postdischarge intervention with 1 or more in-hospital interventions.[10,13,43,45,48,51,59] Three studies covered all stages from hospital admission to postdischarge follow-up.[10,13,59] Analysis of the in-hospital intervention components of Gillespie et al. (2009)[10]—one of the effective studies—revealed that pharmacists participated in ward rounds and as members of the medical team, in contrast to the ineffective studies.[13,59] During those ward rounds, pharmacists discussed the identified drug-related problems with the responsible physicians, which possibly improved implementation of the pharmacists' recommendations. Moreover, at hospital discharge, Gillespie et al. provided the patients' general practitioner with an extensive pharmacist discharge letter containing all in-hospital changes (with rationale), monitoring needs, expected therapeutic goals, and outstanding drug-related problems (with suggested actions).[10] Farris et al. (2014) deployed a similar intervention, but the ineffectiveness could be attributed to the use of a research pharmacist (as mentioned earlier) or lack of contrast between intervention and control groups.[59] So, to be successful in reducing clinical outcomes such as hospital readmission, a more extensive pharmacist presence during all stages might be beneficial. However, it is crucial that the pharmacist acts in close collaboration with either the hospital-based team or the primary care provider.

In-depth analysis of the design of the postdischarge interventions in the 7 multifaceted programs that combined a postdischarge intervention with 1 or more in-hospital interventions showed great variance.[10,13,43,45,48,51,59] The effective studies—Gillespie et al.[10] and López Cabezas et al. (2006)[45]—used a follow-up telephone call to reinforced in-hospital provided interventions, and Schnipper et al. (2006)[51] combined telephone reinforcement with active feedback to primary care providers. Regarding the ineffective studies, Nazareth et al. (2001)[48] supplied the community pharmacists with only the patients' discharge medication regimens and focused on patient compliance and knowledge during the pharmacist house call. Although the intervention was fairly thorough, the community pharmacists were not supplied with the patients' previous clinical histories. Another ineffective study, Kripalani et al. (2012),[13] incorporated a pharmacist follow-up telephone call "as needed," risking the possibility of missing relevant interventions, and the results of Farris et al.[59] might be flawed by a less rigorous implementation of medication-related recommendations postdischarge. Finally, Lipton and Bird (1994)[43] focused mainly on compliance by reducing regimen complexity during a telephone call. So, although not conclusive, evidence tends towards performing a comprehensive postdischarge follow-up based on previous in-hospital interventions by a pharmacist who is equipped with the patient's previous medical history.

Limitations

This review has several strengths. First, the comprehensive search strategy utilized an automated database search of 3 pharmacy-relevant databases with manual reference tracking, which resulted in a complete overview of published studies in this field. Next, all articles were screened and extracted independently by 2 reviewers, ensuring that a solid selection of relevant studies and study characteristics were identified. Finally, because of a detailed data extraction process, it was possible to separate the various pharmacist intervention components.

First, an important limitation of this review is the risk of underreporting the deployed intervention components because of a possible lack of detailed descriptions in the original articles. Since only data from the original articles were extracted for the pharmacist intervention model, important components may have been missed. Second, although a comprehensive literature search was performed, publication bias is an important potential source of bias in systematic reviews.[31] Therefore, unpublished research was not included in our analysis. Third, the selected clinical outcomes for this review were not always the primary outcomes of the included studies, which might result in an included trial being underpowered. Although most included studies were effective on surrogate endpoints (e.g., knowledge or adherence), by excluding these data, only clinically relevant outcomes were investigated implying strong evidence. Finally, we included only articles published in English and may therefore have missed some relevant literature.

Conclusions

Pharmacists can successfully perform interventions across different health care settings.[5,66] Although there is a need for well-designed and well-reported RCTs, this systematic review indicates several pharmacist intervention components that could reduce the risks involved during care transitions. When performing an isolated postdischarge intervention, evidence tends towards collaborating with nurses and tailoring interventions to individual patient needs. In multifaceted intervention programs, performing medication reconciliation alone is possibly insufficient in reducing postdischarge clinical outcomes and should be combined with active patient counseling and a clinical medication review during admission. Furthermore, close collaboration between pharmacists and physicians during all stages of hospitalization is beneficial. Finally, it is important to secure continuity of care by integrating an outreaching hospital pharmacist or a community pharmacist in these multifaceted programs across the health care settings. Ultimately, the pharmacist involved in the intervention needs to be provided with the patient's clinical background and previous hospital experience.

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DISCLOSURES

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Bouvy had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design were contributed by Ensing, Stuijt, Koster, and Bouvy. Data were collected by Ensing and Stuijt and interpretated by Ensing, Stuijt, Karapinar-Çarkit, Koster, and Bouvy. The manuscript was written by Ensing, Stuijt, Koster, and Bouvy and revised by van den Bemt, van Dooren, Karapinar-Çarkit, and Koster.

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APPENDIX A PRISMA Checklist

Section/Topic	#	Checklist Item	Reported on Page #
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	614
Abstract			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	614
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known.	614-15
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	614-15
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No review protocol
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	615, Appendix B
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	615
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	615, Appendix C
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	615
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	615
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	615, Appendix D
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	615
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	615
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	615-16, Table 1
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	615
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	616
Results			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	616, Figure 1, Appendix E
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	616, Table 2, Appendix H, Appendix I
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	616, Appendix F
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot.	616-18, Table 2, Appendix G
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Not applicable
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	616, Appendix F
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	618, Table 3
Discussion			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	618, 621-22
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	623
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	623
Funding			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	623

From: Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement.[30]

APPENDIX B Inclusion and Exclusion Criteria According to PICO for Systematic Review

Inclusion Criteria	
Study design	• (quasi) (cluster) Randomized controlled trial published in English
Population	• Adult participants admitted to a hospital and discharged home
Setting	• Intervention conducted in hospital and/or community pharmacy and/or patients' home
Intervention	• The intervention involved a pharmacist, pregraduate pharmacist, or pharmacy technician • The pharmacist had a proactive role, meaning for all interventions, patients received an active pharmacist intervention (e.g., excluding reactively responding to physician questions during ward rounds) • Interventions were performed before, during, or up to 30 days after hospitalization. The postdischarge time limit was chosen to ensure connection to transitional care • The intervention was designed to improve transitional care and aimed at medication-related issues
Comparison	• The intervention was compared with a control group that received usual care
Clinical outcomes	• At least 1 of the following outcomes was measured: mortality, readmissions, emergency department visits, and adverse drug events
Exclusion Criteria	
Participant	• Intervention conducted solely on pediatric patients or psychiatric patients due to their specific population characteristics
Setting	• Interventions in a palliative care setting or in an intensive care ward due to their specific setting characteristics
Intervention	• Interventions solely targeted at specific drugs (e.g., improving adherence of statins) • Interventions not aimed at transitional care (e.g., interventions in outpatient clinics without transmission of relevant information from earlier health care provider encounters in the hospital or interventions on heart failure guideline adherence)

PICO = participants, interventions, comparisons, and outcomes.

APPENDIX C Search Strategy

MEDLINE

("patient admission"[mesh] OR "patient admission" OR "admission"[TIAB] OR "hospital admission"[TIAB] OR "hospitalization"[mesh] OR "patient discharge"[mesh] OR "discharge"[TIAB] OR "discharged"[TIAB] OR "post discharge"[TIAB] OR "postdischarge"[TIAB] OR "hospitals"[mesh] OR "hospital setting"[TIAB]) AND ("patient education as topic"[mesh] OR "counseling"[mesh] OR "counselling"[TIAB] OR "medication counseling" [TIAB] OR "knowledge"[TIAB] OR "drug knowledge"[TIAB] OR "medicines knowledge"[TIAB] OR "medication knowledge"[TIAB] OR "education"[TIAB] OR "medication understanding"[TIAB] OR "Medication Therapy Management"[mesh] OR "integrated medicines management"[TIAB] OR "medicine* management"[TIAB] OR "drug* management"[TIAB] OR "Medication Errors/prevention and control"[Mesh] OR "medication reconciliation"[mesh] OR "medication reconciliation"[TIAB] OR "medical history taking"[mesh] OR "medication history taking"[TIAB] OR "medication history"[TIAB] OR "medicines histories"[TIAB] OR "continuity of patient care"[mesh] OR "Patient Care Planning"[mesh] OR "discharge planning"[TIAB] OR "discharge service"[TIAB] OR "discharge booklet"[TIAB] OR "follow-up"[TIAB] OR "follow up"[TIAB] OR transition*[TIAB] OR "seamless"[TIAB] OR "care bundle"[TIAB] OR "care coordination"[TIAB] OR "aftercare"[mesh] OR "aftercare"[TIAB] OR "continuity"[TIAB] OR "outreach"[TIAB] OR "co-ordination"[TIAB] OR "coordination"[TIAB] OR "house calls"[mesh] OR "home visit*"[TIAB] OR "house visit*"[TIAB] OR "pharmacy visit"[TIAB] OR "pharmacist visit"[TIAB] OR "home based intervention"[TIAB] OR "telephone call*"[TIAB] OR "telephone"[TIAB] OR "phone call*"[TIAB] OR "phone"[TIAB] OR "medication review"[tw] OR "drug utilization review"[mesh] OR "treatment review"[TIAB] OR "medication review"[TIAB] OR "medicines review"[TIAB] OR "drug review"[TIAB] OR "reviewing medication"[TIAB] OR "monitoring pharmacotherapy"[TIAB] OR "optimizing drug regimens"[TIAB] OR "pharmaceutical care"[TIAB]) AND ("community pharmacy services"[mesh] OR "Pharmacy Service, Hospital"[mesh] OR "pharmaceutical preparations"[mesh] OR "drug prescriptions"[mesh] OR "pharmacists" OR "pharmacist*"OR "pharmacists"[mesh] OR "pharmacy"[TIAB] OR "pharmacist"[TIAB] OR "pharmacists"[TIAB] OR "pharmaceutical"[TIAB] OR "Pharmacists' Aides"[TIAB] OR "pharmacy technician"[TIAB] OR "pharmacy practitioners"[TIAB] OR pharmacy service[TIAB] OR "medication"[TIAB] OR "medication liaison services"[TIAB]) AND (randomized controlled trial[Publication Type] OR (randomized[Title/Abstract] AND controlled[Title/Abstract] AND trial[Title/Abstract]) OR (randomised[Title/Abstract] AND controlled[Title/Abstract] AND trial[Title/Abstract]) OR (random*[Title/Abstract]))

(Limits: English)

EMBASE

#1= 'hospital admission'/de OR 'patient admission' OR 'admission' OR 'hospital admission' OR 'hospitalization'/de OR 'hospital discharge'/de OR 'discharge' OR 'discharged' OR 'post discharge' OR 'postdischarge' OR 'hospital'/de OR 'hospital setting'

#2= 'patient education'/de OR 'counseling'/de OR 'counselling' OR 'medication counseling' OR 'knowledge' OR 'drug knowledge' OR 'medicines knowledge' OR 'medication knowledge' OR 'education' OR 'medication understanding' OR 'medication therapy management'/de OR 'integrated medicines management' OR 'medicine management' OR 'medicines management' OR 'drug management' OR 'drugs management' OR 'medication reconciliation' OR 'medication error'/de OR 'anamnesis'/de OR 'medication history taking' OR 'medication history' OR 'medicines histories' OR 'patient care'/de OR 'patient care planning'/de OR 'discharge planning' OR 'discharge service' OR 'discharge booklet' OR 'follow-up' OR 'follow up' OR 'transition' OR 'seamless' OR 'care bundle' OR 'care coordination' OR 'aftercare'/de OR 'aftercare' OR 'continuity' OR 'outreach' OR 'co-ordination' OR 'coordination' OR 'professional practice'/de OR 'house calls' OR 'home visit' OR 'home visits' OR 'house visit' OR 'house visits' OR 'pharmacy visit' OR 'pharmacist visit' OR 'home based intervention' OR 'telephone call' OR 'telephone calls' OR 'telephone' OR 'phone call' OR 'phone calls' OR 'phone' OR 'pharmaceutical care'/de OR 'drug utilization review' OR 'treatment review' OR 'medication review' OR 'medicines review' OR 'drug review' OR 'reviewing medication' OR 'monitoring pharmacotherapy' OR 'optimizing drug regimens' OR 'pharmaceutical care'

#3= 'pharmacy'/de OR 'hospital pharmacy'/de OR 'drug'/de OR 'prescription'/de OR 'pharmacist'/de OR 'pharmacy technician'/de OR 'drug therapy'/de OR 'pharmacy' OR 'pharmacist' OR 'pharmacists' OR 'pharmaceutical' OR 'pharmacists aides' OR 'pharmacy technician' OR 'pharmacy practitioners' OR 'pharmacy service' OR 'medication' OR 'medication liaison services'

APPENDIX C Search Strategy *(continued)*

#4= 'randomized controlled trial'/de OR 'randomized controlled trial (topic)'/de OR (randomized AND controlled AND trial)

#5= #1 AND #2 AND #3 AND #4

(Limits: English AND human studies AND EMBASE)

International Pharmaceutical Abstracts

#1= TI ("patient admission" OR "admission" OR "hospital admission" OR "hospitalization" OR "patient discharge" OR "discharge" OR "discharged" OR "post discharge" OR "postdischarge" OR "hospitals" OR "hospital setting") OR AB ("patient admission" OR "admission" OR "hospital admission" OR "hospitalization" OR "patient discharge" OR "discharge" OR "discharged" OR "post discharge" OR "postdischarge" OR "hospitals" OR "hospital setting")

#2= TI ("patient education" OR "counseling" OR "counselling" OR "medication counseling" OR "knowledge" OR "drug knowledge" OR "medicines knowledge" OR "medication knowledge" OR "education" OR "medication understanding" OR "Medication Therapy Management" OR "integrated medicines management" OR "medicine* management" OR "drug* management" OR "Medication Errors" OR "medication reconciliation" OR "medication reconciliation" OR "medical history taking" OR "medication history" OR "medicines histories" OR "continuity of patient care" OR "Patient Care Planning" OR "discharge planning" OR "discharge service" OR "discharge booklet" OR "follow-up" OR "follow up" OR transition* OR "seamless" OR "care bundle" OR "care coordination" OR "aftercare" OR "continuity" OR "outreach" OR "co-ordination" OR "coordination" OR "house calls" OR "home visit*" OR "house visit*" OR "pharmacy visit" OR "pharmacist visit" OR "home based intervention" OR "telephone call*" OR "telephone" OR "phone call*" OR "phone" OR "medication review" OR "drug utilization review" OR "treatment review" OR "medication review" OR "medicines review" OR "drug review" OR "reviewing medication" OR "monitoring pharmacotherapy" OR "optimizing drug regimens" OR "pharmaceutical care") OR AB ("patient education" OR "counseling" OR "counselling" OR "medication counseling" OR "knowledge" OR "drug knowledge" OR "medicines knowledge" OR "medication knowledge" OR "education" OR "medication understanding" OR "Medication Therapy Management" OR "integrated medicines management" OR "medicine* management" OR "drug* management" OR "Medication Errors" OR "medication reconciliation" OR "medication reconciliation" OR "medical history taking" OR "medication history" OR "medicines histories" OR "continuity of patient care" OR "Patient Care Planning" OR "discharge planning" OR "discharge service" OR "discharge booklet" OR "follow-up" OR "follow up" OR transition* OR "seamless" OR "care bundle" OR "care coordination" OR "aftercare" OR "continuity" OR "outreach" OR "co-ordination" OR "coordination" OR "house calls" OR "home visit*" OR "house visit*" OR "pharmacy visit" OR "pharmacist visit" OR "home based intervention" OR "telephone call*" OR "telephone" OR "phone call*" OR "phone" OR "medication review" OR "drug utilization review" OR "treatment review" OR "medication review" OR "medicines review" OR "drug review" OR "reviewing medication" OR "monitoring pharmacotherapy" OR "optimizing drug regimens" OR "pharmaceutical care")

#3= TI ("community pharmacy services" OR "Hospital Pharmacy Service" OR "pharmaceutical preparations" OR "drug prescriptions" OR "pharmacist*" OR "pharmacy" OR "pharmaceutical" OR "Pharmacists' Aides" OR "pharmacy technician" OR "pharmacy practitioners" OR "pharmacy service" OR "medication" OR "medication liaison services") OR AB ("community pharmacy services" OR "Hospital Pharmacy Service" OR "pharmaceutical preparations" OR "drug prescriptions" OR "pharmacist*" OR "pharmacy" OR "pharmaceutical" OR "Pharmacists' Aides" OR "pharmacy technician" OR "pharmacy practitioners" OR "pharmacy service" OR "medication" OR "medication liaison services")

#4= TI ("randomized controlled trial" OR (randomized AND controlled AND trial) OR (randomised AND controlled AND trial) OR random*) OR AB ("randomized controlled trial" OR (randomized AND controlled AND trial) OR (randomised AND controlled AND trial) OR random*)

#5= #1 AND #2 AND #3 AND #4

(Limits: English AND human studies)

APPENDIX D List of Extracted Parameters

Cluster	Data Abbreviation	Data Description
Study reference	Author	Primary author of reference
	Full title	Full title
	YoP	Year of publication
	YoE	Year of execution
Study design	Design	Design of study
	Specific setting of study	Multi/single center
		Type of hospital
		Number of beds
		Specific wards?
	Country	Country where study was performed
	Funding	Was the study funded?
	C.o.I.	Have the authors reported a conflict of interest?
	Objective	Description of the main objective of the conducted study
Method	Inclusion criteria	All inclusion criteria as reported in original study
	Exclusion criteria	All exclusion criteria as reported in original study
	Usual care	Description of usual care
	Years of experience	Years of experience from the performer
	Protocol training	What kind of training was received by personnel performing the intervention?
	According to protocol	Did the personnel have protocols to perform the intervention?
	Who is collaborating with the pharmacist?	Who: Which other health care providers performed an intervention?
		What: Describe the intervention of the OTHER health care provider
		Communication: How did they communicate?
	Access to medical information	Does the performing pharmacist have access to medical information and in what way?
	Pharmacy intervention	When: At what time during hospitalization is the pharmacy intervention performed?
		What: Description of intervention performed
		Who: Which member of the pharmacy staff is performing the intervention?
		Time spent: Total time spent of intervention
Patient characteristics	Total Nr. assessed	Number of patients that are assessed for eligibility in the study
	Total Nr. randomized	Number of patients that are randomized in the study
	Significant differences at baseline	Are there significant differences at baseline?
		Describe the differences
	Nr. randomized patients: I and C	Number of patients in intervention group and control group after randomization
	Male %	Percentage of men in study
	Age: I and C	Mean age, range and standard deviation of intervention and control groups
	Health state	Main: Primary diagnosis of population group (e.g., heart failure)
		Total number of comorbidities
		How are the total number of comorbidities measured?
	Nr. medication	When: At what time during hospitalization?
		Mean number, range, and standard deviation of medication in intervention and control groups
	% living alone: I and C	Percentage living alone in intervention and control groups
	Nr of hospitalizations	Mean number of previous hospitalizations in intervention and control groups
		Time: during which time frame?
	Other demographic information	If mentioned in study, for example, education, ethnicity, social class
Outcomes	Outcomes	Outcome in short
		Primary outcome
		Definition: report the outcome as described by authors
		Method: how is the outcome measured?
		When: when is the outcome measured (=endpoint)?
		What: what is exactly measured?
	Nr. of patients analyzed	Number of patients in intervention group and control group for analysis
		Characteristics of the (different) outcomes
		Statistics of the outcomes
	Other outcomes	Definition, method, endpoint of measurement, percentages, significance
Other	Limitations	Limitations as mentioned by the authors
	Conclusion	Conclusion as mentioned by the authors
	Comments	Relevant/notable comments
Reviewer	Name	Clementine Stuijt or Rik Ensing
	Date	Date of data extraction
	Check	Checked by second reviewer: type name

APPENDIX E Inter-Rater Agreement Calculation for Full-Text Assessment

		HE		
		N	Y	Total
CS	N	90	6	96
	Y	2	28	30
	Total	92	34	126

CS = author/reviewer Clementine C.M. Stuijt; HE = author/reviewer Hendrik T. Ensing; N = no; Y = yes.

Observed similarity: ((90 + 28)/126) × 100 = 94%

Kappa calculation formula:

- $\kappa = \frac{(Pr(a) - Pr(e)}{1 - Pr(e)}$

In which:

Pr(*a*) = relative observed agreement among raters = (90 + 28)/126 = 0.94

To calculate Pr(*e*) (the probability of random agreement):

- Ensing said "Y" to 34 articles and "N" to 92 articles: Thus "Y" is 0.37 of the time.
- Stuijt said "Y" to 30 articles and "N" to 96 articles. Thus "Y" is 0.31 of the time.
- The probability that both say "Y" is 0.37 × 0.31 = 0.11.
- The probability that both say "N" is (1–0.37) × (1–0.31) = 0.43.
- Thus the overall probability of random agreement is Pr(*e*) = 0.11 + 0.43 = 0.54.

Resulting in:

- $\kappa = \frac{0.94 - 0.54}{1 - 0.54} = 0.87$ (0.81–1 *is almost perfect*)

APPENDIX F Reason for Excluding Articles After Full-Text Review

Primary Author	Primary Title	Publication Year	Reason for Exclusion
Adepu, R	Influence of postdischarge counselling on health outcomes in diabetic and hypertensive patients	2011	Study design
Ahmed, A	Quality and outcomes of heart failure care in older adults: role of multidisciplinary disease-management programs	2002	Study design
Allen, K	A randomized trial testing the superiority of a postdischarge care management model for stroke survivors	2009	No pharmacist intervention
Anderegg, S	Acceptance of recommendations by inpatient pharmacy case managers: unintended consequences of hospitalist and specialist care	2013	Study design
Backes, A	Primary medication adherence among patients transitioning from hospital to home care	2012	Meeting report or editorial
Baker, D	Evaluation of drug information for cardiology patients	1991	No pharmacist intervention
Baker, DM	A study contrasting different modalities of medication discharge counseling	1984	Outcome not included in review
Basoor, A	Result of quality improvement discharge tool in congestive heart failure-randomized controlled trial	2011	Study design
Becerra-Camargo, J	A multicentre, double-blind, randomised, controlled, parallel-group study of the effectiveness of a pharmacist-acquired medication history in an emergency department	2013	Outcome not included in review
Beckett, RD	Effectiveness and feasibility of pharmacist-led admission medication reconciliation for geriatric patients	2012	Outcome not included in review
Beney, J	Effect of telephone follow-up on the physical well-being dimension of quality of life in patients with cancer	2002	Outcome not included in review
Bladh, L	Effects of a clinical pharmacist service on health-related quality of life and prescribing of drugs: a randomised controlled trial	2011	Outcome not included in review
Blix, HS	Characteristics of drug-related problems discussed by hospital pharmacists in multidisciplinary teams	2006	Study design
Bollella, G	Optimal level of liaison pharmacist intervention to facilitate a post-discharge home medicines review	2008	Outcome not included in review
Bonnet-Zamponi, D	Drug-related readmissions to medical units of older adults discharged from acute geriatric units: results of the Optimization of Medication in AGEd multicenter randomized controlled trial	2013	No pharmacist intervention
Brullet, E	A randomized study of the safety of outpatient care for patients with bleeding peptic ulcer treated by endoscopic injection	2004	No pharmacist intervention
Burnett, KM	Effects of an integrated medicines management program on medication appropriateness in hospitalized patients	2009	Outcome not included in review
Calvert, SB	Patient-focused intervention to improve long-term adherence to evidence-based medications: a randomized trial	2012	Outcome not included in review
Cannon, J	Pharmaceutical care provision to elderly patients: assessment of its impact on compliance and discharge medication changes	1999	Outcome not included in review
Cawthon, C	Improving care transitions: the patient perspective	2012	Study design
Ching, CL	Impact of pharmaceutical care on readmission rates and quality of life in coronary artery disease patients	2002	Meeting report or editorial
Connor, MO	Prevention of adverse drug events in hospitalised older patients: a randomised controlled trial	2012	Meeting report or editorial
Cordasco, KM	A low-literacy medication education tool for safety-net hospital patients	2009	No pharmacist intervention
Davidson, J	Pre-discharge counseling in the elderly: what difference does it make?	1989	Outcome not included in review
de Wit, R	Improving the quality of pain treatment by a tailored pain education programme for cancer patients in chronic pain	2001	No pharmacist intervention
Doughty, RN	Randomized, controlled trial of integrated heart failure management: the Auckland Heart Failure Management Study	2002	No pharmacist intervention
Dromerick, AW	Preventing recurrence of thromboembolic events through coordinated treatment in the District of Columbia	2011	No pharmacist intervention
Eggink, RN	The effect of a clinical pharmacist discharge service on medication discrepancies in patients with heart failure	2010	Outcome not included in review
Esposito, L	The effects of medication education on adherence to medication regimens in an elderly population	1995	No pharmacist intervention
Ferrante, D	Long-term results after a telephone intervention in chronic heart failure: DIAL (Randomized Trial of Phone Intervention in Chronic Heart Failure) follow-up	2010	No pharmacist intervention
Gallagher, PF	Prevention of potentially inappropriate prescribing for elderly patients: a randomized controlled trial using STOPP/START criteria	2011	No pharmacist intervention

APPENDIX F Reason for Excluding Articles After Full-Text Review *(continued)*

Primary Author	Primary Title	Publication Year	Reason for Exclusion
Gattis, WA	Reduction in heart failure events by the addition of a clinical pharmacist to the heart failure management team: results of the Pharmacist in Heart Failure Assessment Recommendation and Monitoring (PHARM) Study	1999	No transitional care
George, L	Impact of a surgical preadmission clinic pharmacist on the quality of medication management from preadmission to discharge: a randomised controlled study	2011	Outcome not included in review
Gizzi, LA	Assessment of a safety enhancement to the hospital medication reconciliation process for elderly patients	2010	Outcome not included in review
Hale, AR	Perioperative medication management: expanding the role of the preadmission clinic pharmacist in a single centre, randomised controlled trial of collaborative prescribing	2013	Outcome not included in review
Haq, N	Impact of pharmacists-led intervention programme towards knowledge, attitude and practice among hepatitis B patients in Pakistan: a nonclinical randomized controlled trial	2013	Meeting report or editorial
Holland, R	Delivering a home-based medication review: process measures from the HOMER randomised controlled trial	2006	Outcome not included in review
Holmes-Rovner, M	Does outpatient telephone coaching add to hospital quality improvement following hospitalization for acute coronary syndrome?	2008	No pharmacist intervention
Huang, A	The medication reconciliation process: keys to success	2012	Meeting report or editorial
Israel, EN	Underutilization of cardiovascular medications: effect of a continuity-of-care program	2013	Outcome not included in review
Khdour, MR	Clinical pharmacy-led disease and medicine management programme for patients with COPD	2009	No transitional care
Kimball, S	Testing a teaching appointment and geragogy-based approach to medication knowledge at discharge	2010	Study design
Kripalani, S	Pharmacist intervention for low literacy in cardiovascular disease (PILL-CVD): a randomized controlled trial	2011	Meeting report or editorial
Kucukarslan, SN	Pharmacists on rounding teams reduce preventable adverse drug events in hospital general medicine units	2003	Study design
Kwan, Y	Pharmacist medication assessments in a surgical preadmission clinic	2007	Outcome not included in review
Lalonde, L	Effectiveness of a medication discharge plan for transitions of care from hospital to outpatient settings	2008	Outcome not included in review
Laramee, AS	Case management in a heterogeneous congestive heart failure population: a randomized controlled trial	2003	No pharmacist intervention
Linne, AB	Effects of systematic education on heart failure patients' knowledge after 6 months: a randomised controlled trial	1999	Outcome not included in review
Lowe, CJ	Effects of self-medication programme on knowledge of drugs and compliance with treatment in elderly patients	1995	Outcome not included in review
Mannheimer, B	Drug-related problems and pharmacotherapeutic advisory intervention at a medicine clinic	2006	No pharmacist intervention
Marotti, SB	A randomised controlled trial of pharmacist medication histories and supplementary prescribing on medication errors in postoperative medications	2011	Outcome not included in review
Marusic, S	The effect of pharmacotherapeutic counseling on readmissions and emergency department visits	2013	No pharmacist intervention
Menditto, E	A ten years longer life: a therapeutic education program for hypertensive patients	2012	Meeting report or editorial
Muniz, J	The effect of post-discharge educational intervention on patients in achieving objectives in modifiable risk factors six months after discharge following an episode of acute coronary syndrome, (CAM-2 Project): a randomized controlled trial	2010	No pharmacist intervention
Murray, MD	Effect of a pharmacist on adverse drug events and medication errors in outpatients with cardiovascular disease	2009	No transitional care
Nickerson, A	Drug-therapy problems, inconsistencies and omissions identified during a medication reconciliation and seamless care service	2005	Outcome not included in review
O'Connor, M	Prevention of adverse drug events in hospitalized older patients: a randomised controlled trial using STOPP/START criteria	2012	Meeting report or editorial
Olson, KL	Outcomes of patients discharged from pharmacy-managed cardiovascular disease management	2009	No transitional care
Owens, NJ	The senior care study: the relationship between optimal pharmacotherapy and patient mental status	1990	Meeting report or editorial
Pacini, M	Home-based medication review in older people: is it cost effective?	2007	Outcome not included in review

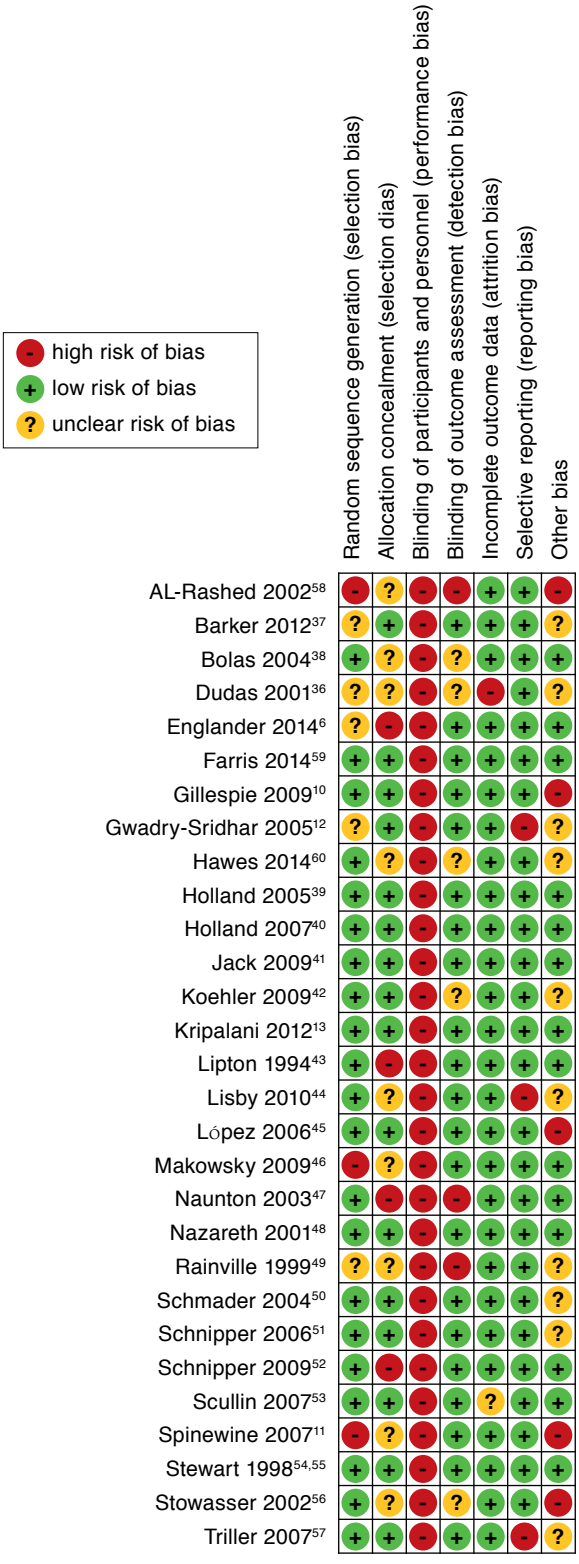
APPENDIX F Reason for Excluding Articles After Full-Text Review *(continued)*

Primary Author	Primary Title	Publication Year	Reason for Exclusion
Pai, AB	Reduced drug use and hospitalization rates in patients undergoing hemodialysis who received pharmaceutical care: a 2-year, randomized, controlled study	2009	No transitional care
Parry, C	The care transitions intervention: a patient-centered approach to ensuring effective transfers between sites of geriatric care	2003	No pharmacist intervention
Perera, KY	Medium of language in discharge summaries: would the use of native language improve patients' knowledge of their illness and medications?	2012	No pharmacist intervention
Peterson, GM	Impact of pharmacist-conducted home visits on the outcomes of lipid-lowering drug therapy	2004	Targets specific drug
Pitner, J	Specialty geriatric evaluation and management teams reduce adverse drug reactions	2004	Meeting report or editorial
Polack, J	Evaluation of different methods of providing medication-related education to patients following myocardial infarction	2008	Outcome not included in review
Raynor, DK	Effects of computer generated reminder charts on patients' compliance with drug regimens	1993	Outcome not included in review
Rice, KL	Disease management program for chronic obstructive pulmonary disease: a randomized controlled trial	2010	No pharmacist intervention
Rich, MW	Effect of a multidisciplinary intervention on medication compliance in elderly patients with congestive heart failure	1996	No pharmacist intervention
Rienstra, M	A specialized atrial fibrillation clinic: Improving care and costs for patients with atrial fibrillation	2013	Meeting report or editorial
Robinson, A	Guided self-management and patient-directed follow-up of ulcerative colitis: a randomised trial	2001	No pharmacist intervention
Sadik, A	Pharmaceutical care of patients with heart failure	2005	No transitional care
Salanitro, A	Factors associated with admission and discharge medication reconciliation errors at 2 teaching hospitals	2011	Study design
Salanitro, AH	Effect of patient- and medication-related factors on inpatient medication reconciliation errors	2012	Study design
Saleem, F	A non-clinical randomized controlled trial assessing impact of pharmacists led intervention programme for enhancing medication adherence and health-related quality of life	2012	Meeting report or editorial
Sanchez Ulayar, A	Pharmaceutical intervention upon hospital discharge to strengthen understanding and adherence to pharmacological treatment	2012	Full-text not in English
Schwaab, B	In-patient cardiac rehabilitation versus medical care - a prospective multicentre controlled 12 months follow-up in patients with coronary heart disease	2011	No pharmacist intervention
Shah, M	Diabetes transitional care from inpatient to outpatient setting: pharmacist discharge counseling	2013	Outcome not included in review
Simpson, TRG	A comprehensive case management programme to prevent chronic obstructive pulmonary disease hospitalisations	2013	Meeting report or editorial
Smith, L	An investigation of hospital generated pharmaceutical care when patients are discharged home from hospital	1997	Outcome not included in review
Stamatakis, MK	Effectiveness of a pharmacist-initiated continuity of care program for chronic dialysis patients	1998	Study design
Stewart, S	Home-based management for chronic heart failure reduces recurrent hospital stay and total healthcare costs compared with a clinic-based program: results from the WHICH? Trial	2012	Study design
Stowasser, DA	A randomised controlled trial of medication liaison services - acceptance and use by health professionals	2002	Outcome not included in review
Talasaz, AH	The potential role of clinical pharmacy services in patients with cardiovascular diseases	2012	Study design
Tompson, AJ	Utilizing community pharmacy dispensing records to disclose errors in hospital admission drug charts	2012	Outcome not included in review
Tsuyuki, RT	A multicenter disease management program for hospitalized patients with heart failure	2004	Mo pharmacist intervention
Ulrik, CS	No benefit and potential harm with an educational and care management programme for chronic obstructive pulmonary disease	2013	Meeting report or editorial
Van der Linden, L	Reduction of polypharmacy in geriatric inpatients using the RASP list: a cluster-randomized controlled trial	2013	Meeting report or editorial
Vuong, T	Implementation of a community liaison pharmacy service: a randomised controlled trial	2008	Outcome not included in review
Wei, L	Effect of pharmaceutical care on medication adherence and hospital admission in patients with chronic obstructive pulmonary disease (COPD): a randomized controlled study	2014	No transitional care
Williams, JB	Secondary prevention after coronary artery bypass graft surgery: findings of a national randomized controlled trial and sustained society-led incorporation into practice	2011	No pharmacist intervention

APPENDIX F Reason for Excluding Articles After Full-Text Review *(continued)*

Primary Author	Primary Title	Publication Year	Reason for Exclusion
Williams, M	Project impact: Improving patient adherence through communication at transition	2013	Meeting report or editorial
Williford, SL	Impact of pharmacist counseling on medication knowledge and compliance	1995	Outcome not included in review
Willoch, K	Handling drug-related problems in rehabilitation patients: a randomized study	2012	No transitional care
Wu, JR	Effect of a medication-taking behavior feedback theory-based intervention on outcomes in patients with heart failure	2012	No pharmacist intervention
Zerafa, N	Impact of drugs counselling by an undergraduate pharmacist on cardiac surgical patient's compliance to medicines	2011	Outcome not included in review
Zermansky, AG	Clinical medication review by a pharmacist of patients on repeat prescriptions in general practice: A randomised controlled trial	2002	No transitional care
Zhao, Y	Effects of a postdischarge transitional care programme for patients with coronary heart disease in China: a randomised controlled trial	2009	No pharmacist intervention

APPENDIX G Risk of Bias of Included Studies



APPENDIX H Cross-Tab Intervention Versus Outcome Measurement

	Outcome Measurement							
Pharmacist Intervention	**Mortality**	**Readmissions**	**ED Visits**	**Composite RE**	**Composite RM**	**Composite REM**	**ADEs**	**Sum Row**
1. Admission reconciliation	5	7	4	3	-	-	3	**22**
2. Patient counseling at admission	2	3	1	1	-	-	-	**7**
3. Pharmacist is part of medical team	2	4	2	1	-	1	-	**10**
4. Medication review	5	7	4	4	-	2	2	**24**
5. Patient counseling during admission	3	6	3	2	-	2	2	**18**
6. Discharge reconciliation	4	8	2	2	-	-	1	**17**
7. Patient counseling at discharge	5	10	3	3	-	-	2	**23**
8. Patient discharge letter	3	6	2	1	-	1	2	**15**
9. Transmission	5	8	3	2	-	-	1	**19**
10. Patient-centered follow-up	10	16	7	5	2	1	2	**43**
11. HCP-centered follow-up	8	12	5	2	2	-	2	**31**
12. Extra postdischarge follow-up	5	8	1	-	-	1	1	**16**
13. Tailored intervention	5	5	3	1	2	-	1	**17**
14. Provision of adherence aides	3	5	3	-	2	-	2	**15**
15. Dispensing/logistics aides	5	6	1	-	-	-	-	**12**
Sum column	**70**	**111**	**44**	**27**	**8**	**8**	**21**	

ADEs = adverse drug events; ED = emergency department; HCP = health care provider; RE = readmissions and ED visits; REM = readmissions, ED visits, and mortality; RM = readmissions and mortality.

APPENDIX I Categorization of Interventions Performed by Other Health Care Providers

Author	HCP Type	Performed Intervention	Categorization
Barker et al., 2012[37]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Dudas et al., 2001[36]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Englander et al., 2014[6]	N	Coaching and education, including postdischarge phone calls and home visits for highest risk patients	Coordination, counseling, risk assessment
Farris et al., 2014[59]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Gillespie et al., 2009[10]	S	Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	Act on drug-related recommendations (DA)
Gwadry-Sridhar et al., 2005[12]	N	Patient counseling is a team intervention with pharmacist	Counseling
Holland et al., 2005[39]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Holland et al., 2007[40]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Jack et al., 2009[41]	N	Coordinate discharge plan, educate, and prepare patients for discharge	Coordination, counseling
	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Koehler et al., 2009[42]	SN	Daily condition specific education, identify and address discharge barriers, self-management discharge teaching, follow-up call at 5-7 days postdischarge	Counseling
	S	Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	Act on drug-related recommendations (DA)
Kripalani et al., 2012[13]	SW	Assistance obtaining discharge medications	Coordination
	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Lipton and Bird, 1994[43]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Makowsky et al., 2009[46]	S	Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	Act on drug-related recommendations (DA)
Naunton et al., 2003[47]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Nazareth et al., 2001[48]	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Rainville, 1999[49]	SN	Identify patients with potential rehospitalization risks and determined corrective action	Risk assessment and referral
	S	Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	Act on drug-related recommendations (DA)
Schmader et al., 2004[50]	S	Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	Act on drug-related recommendations (DA)
Schnipper et al., 2006[51]	S	Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	Act on drug-related recommendations (DA)
	PCP	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)
Schnipper et al., 2009[52]	S	1. Taking preadmission medication histories (PMH), referring to PMH at discharge 2. Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	1. Reconciliation 2. Act on drug-related recommendations (DA)
	N	Performing discharge counseling	Counseling
Scullin et al., 2007[53]	S	Assessment of drug-related recommendations identified by pharmacists' clinical medication reviews and acting upon them if deemed necessary	Act on drug-related recommendations (DA)
Stewart et al., 1998[54]	N	Predischarge patient treatment adherence counseling, report clinical deterioration. At home visit: detect clinical deterioration or adverse drug events and referral to GP	Counseling, risk assessment, and referral
Stewart et al., 1998[55]	N	Predischarge patient treatment adherence counseling, report clinical deterioration. At home visit: detect clinical deterioration or adverse drug events and referral to GP	Counseling, risk assessment, and referral
Stowasser et al., 2002[56]	GP, CP	Confirmation medication history at admission	Verification
Triller et al., 2007[57]	S	Assessment of drug-related recommendations identified by pharmacists' postdischarge follow-ups and acting upon them if deemed necessary	Act on drug-related recommendations (PD)

CP = community pharmacist; DA = during admission; GP = general practitioner; N = nurse; PCP = primary care provider; PD = postdischarge; S = specialist; SN = specialized nurse; SW = social worker.

APPENDIX J Categorization of Interventions Performed Per Included Study

	Pharmacist Intervention[a]														
Study Author/Date	**1**	**2**	**3**	**4[b]**	**5**	**6**	**7**	**8**	**9**	**10[c]**	**11**	**12**	**13**	**14**	**15**
Al-Rashed et al., 2002[58]							●							●	
Barker et al., 2012[37]										**H**	●	●			●
Bolas et al., 2004[38]	●	●			●	●	●	●	●						●
Dudas et al., 2001[36]										**T**	●				
Englander et al., 2014[6]				**1**	●	●									●
Farris et al., 2014[59]	●				●	●	●	●	●	**T**	●	●		●	
Gillespie et al., 2009[10]	●	●	●	**3**	●		●	●	●	**T**			●		
Gwadry-Sridhar et al., 2005[12]				**2**	●			●							
Hawes et al., 2014[60]										**C**					
Holland et al., 2005[39]										**H**	●	●			●
Holland et al., 2007[40]										**H**	●	●			●
Jack et al., 2009[41]										**T**	●				
Koehler et al., 2009[42]	●			**3**	●	●	●		●	**T**					
Kripalani et al., 2012[13]	●			**2**	●		●	●		**T**	●		●	●	
Lipton and Bird, 1994[43]							●			**T**	●	●			
Lisby et al., 2010[44]	●			**1**											
López Cabezas et al., 2006[45]							●			**T**					
Makowsky et al., 2009[46]	●		●	**3**		●	●	●	●						
Naunton et al., 2003[47]										**H**	●			●	
Nazareth et al., 2001[48]						●	●	●	●	**H**	●		●		
Rainville, 1999[49]			●	**3**	●					**T**		●			
Schmader et al., 2004[50]			●	**3**											
Schnipper et al., 2006[51]				**3**		●	●			**T**	●				
Schnipper et al., 2009[52]	●			**3**											
Scullin et al., 2007[53]	●	●		**3**	●	●	●	●	●				●		●
Spinewine et al., 2007[11]	●		●	**1**			●		●						
Stewart et al., 1998[54]										**H**	●		●	●	
Stewart et al., 1998[55]										**H**	●		●	●	
Stowasser et al., 2002[56]	●					●			●						
Triller et al., 2007[57]										**H**	●	●			

[a]*Pharmacist intervention; number according to the pharmacist intervention model (Table 1).*
[b]*Medication review levels: 1 = prescription review, 2 = adherence support review (with patient present), 3 = clinical review, 4 = clinical review with prescribing.*
[c]*Patient-centered follow-up: C = clinic visit, H = home visit, T = telephone call.*