HEALTH CARE REFORM

Hospital-Based Medication Reconciliation Practices

A Systematic Review

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Background: Medication discrepancies at care transitions are common and lead to patient harm. Medication reconciliation is a strategy to reduce this risk.

Objectives: To summarize available evidence on medication reconciliation interventions in the hospital setting and to identify the most effective practices.

Data Sources: MEDLINE (1966 through February 2012) and a manual search of article bibliographies.

Study Selection: Twenty-six controlled studies.

Data Extraction: Data were extracted on study design, setting, participants, inclusion/exclusion criteria, intervention components, timing, comparison group, outcome measures, and results.

Data Synthesis: Studies were grouped by type of medication reconciliation intervention—pharmacist related, information technology (IT), or other—and were assigned quality ratings using US Preventive Services Task Force criteria.

Results: Fifteen of 26 studies reported pharmacist-related interventions, 6 evaluated IT interventions, and 5 studied other interventions. Six studies were classified as good quality. The comparison group for all the studies was usual care; no studies compared different types of interventions. Studies consistently demonstrated a reduction in medication discrepancies (17 of 17 studies), potential adverse drug events (5 of 6 studies), and adverse drug events (2 of 2 studies) but showed an inconsistent reduction in postdischarge health care utilization (improvement in 2 of 8 studies). Key aspects of successful interventions included intensive pharmacy staff involvement and targeting the intervention to a high-risk patient population.

Conclusions: Rigorously designed studies comparing different inpatient medication reconciliation practices and their effects on clinical outcomes are scarce. Available evidence supports medication reconciliation interventions that heavily use pharmacy staff and focus on patients at high risk for adverse events. Higher-quality studies are needed to determine the most effective approaches to inpatient medication reconciliation.

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ADVERSE DRUG EVENTS (ADEs), defined as patient injuries related to using a drug,[1] are an epidemic patient safety issue, occurring in 5% to 40% of hospitalized patients and in 12% to 17% of patients after hospital discharge.[2,3] Transitions of care, such as hospital admission and discharge, contribute to ADEs in part through medication discrepancies, that is, unexplained differences in documented medication regimens across different sites of care.[4,5] Medication discrepancies are common, occurring in up to 70% of patients at hospital admission or discharge,[6-10] with almost one-third of these having the potential to cause patient harm (ie, potential ADEs [PADEs]).[10] ADEs associated with medication discrepancies can prolong hospital stays and, in the postdischarge period, may lead to emergency department visits, hospital readmissions, and use of other health care resources.[11,12]

See Invited Commentary at end of article

Medication reconciliation is a strategy for reducing the occurrence of medication discrepancies that may lead to ADEs. Medication reconciliation is the "process of identifying the most accurate list of all medications a patient is taking . . . and using this list to provide correct medications for patients anywhere within the health care system." [13(p1)] Recognizing the potential impact of properly reconciling medications

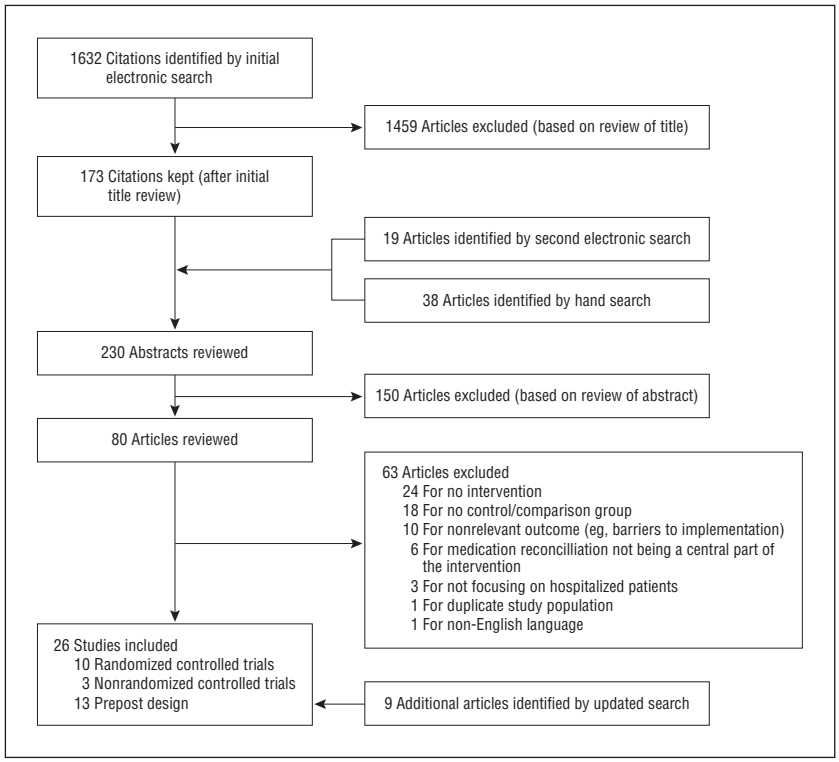

Figure. Selection process for study inclusion.

during care transitions, in 2005 The Joint Commission added medication reconciliation to its list of National Patient Safety Goals.[14]

During the last decade, various medication reconciliation interventions have been described, but the specific elements important to successful efforts have not been fully appreciated. We performed a systematic review of the literature to summarize the available evidence on medication reconciliation in the hospital setting and to identify the most effective practices.

METHODS

DATA SOURCES AND SEARCHES

We initially performed a systematic search of English-language articles published between January 1, 1966, and October 31, 2010, on medication reconciliation during patient hospitalization. Using MEDLINE, we first searched a combination of Medical Subject Headings and keywords, including *medication reconciliation; medication errors/prevention and control; medication systems, hospital; medical records systems, computerized; medication list; medication record;* and *patient discharge.* Second, we searched *medication reconciliation interventions* combined with *patient admission*, and we mannually searched the reference lists for relevant articles. We later updated the literature search through February 29, 2012.

STUDY SELECTION

Controlled intervention studies that met the following criteria were eligible for inclusion: English language, medication reconciliation was the primary focus of the intervention, the comparison group was defined, the intervention was clearly described, the intervention occurred in the hospital during hospitalization or transition in or out of the hospital, and quantitative results were provided. One reviewer (S.K.M. or K.C.S.) performed initial independent assessments of titles for relevance and subsequent examination of abstracts and articles for inclusion, which was then verified by a second reviewer (S.K.M. or K.C.S.). Discrepancies were resolved by a third reviewer (J.L.S. or S.K.).

DATA EXTRACTION

One reviewer (S.K.M.) extracted relevant data from included articles, which was then verified by 2 others (K.C.S. and J.L.S.). Information was obtained regarding study design, setting, number of participants, inclusion/exclusion criteria, components of the intervention, timing of the intervention related to hospital course, comparison group, outcome measures, and results (for the data extraction tool see the eAppendix; http://www.archinternmed.com).

DATA SYNTHESIS AND ANALYSIS

Studies were first grouped into the following 3 categories, based on the primary component of the intervention: (1) pharmacist related, (2) information technology (IT), or (3) other type. Two authors (S.K.M. and J.L.S.) then collectively determined 4 common types of reported outcomes, including (1) medication discrepancies, defined as unexplained differences in documented medication regimens across different sites of care; (2) PADEs, defined as medication discrepancies with potential to cause patient harm; (3) ADEs, defined as patient injuries related to using a drug; and (4) health care utilization, defined as postdischarge emergency department visits, hospital readmissions, and use of other health care resources. Meta-analysis was infeasible owing to heterogeneity in methods, interventions, and reported outcomes. Two authors (S.K.M. and S.K.) categorized study quality as "good," "fair," or "poor" on the basis of US Preventive Services Task Force criteria[15]; adaptations were made for pre-post studies.

OBSERVATIONAL (NONCONTROLLED) STUDIES

Intervention studies that lacked a control group but otherwise met the inclusion criteria were abstracted and summarized in a similar manner, although they are not the subject of this review (eAppendix).

RESULTS

Of the 1632 articles initially identified via electronic search, 173 abstracts were reviewed. A second electronic search and hand search of references yielded an additional 57 abstracts. Of the 230 abstracts reviewed, 80 publications warranted full review, and 17 of these met the inclusion criteria. An updated search identified 9 additional articles, for an inclusive total of 26 studies (**Figure**). Among the included articles were 10 randomized controlled trials, 3 nonrandomized trials with a concurrent control group, and 13 pre-post studies. Fourteen of the studies were con-

ducted in countries other than the United States, including Canada,[16,17] Australia,[18,19] New Zealand,[20] Northern Ireland,[21] United Kingdom,[22] Belgium,[23] Denmark,[24] the Netherlands,[25] and Sweden.[26-29]

Fifteen studies reported on pharmacist-related interventions,[16-19,21,22,24-26,28-33] 6 reported on IT-focused interventions,[34-39] and 5 reported on other types of interventions, including educating staff about medication reconciliation[20,40] and use of a standardized medication reconciliation tool.[23,27,41] Most studies (15 of 26) were classified as poor quality,* 5 were classified as fair quality,[16,17,26,32,33] and the remaining 6 were classified as good quality.[24,25,28,31,36,39] A summary of the timing and components of the interventions and study quality is given in **Table 1**, and the results are summarized in **Table 2**. The comparison group in each study was "usual care," as defined in Table 1.

The 15 studies involving pharmacist-related interventions included diverse roles of the pharmacy staff in the medication reconciliation process and varied timing of pharmacy staff involvement during the patient's hospitalization. Four of 15 studies were rated as good quality (Table 1).[24,25,28,31] Most of these studies involved licensed pharmacists, although pharmacy residents[32] and pharmacy technicians[30] were also used. Most of these interventions reduced medication discrepancies (10 of 10 studies)[16-19,21,22,25,26,30,33] and PADEs (2 of 3 studies)[16,18,25] but less often reduced preventable ADEs (1 study)[31] and health care utilization (2 of 7 studies)[21,24,28,29,31-33] (Table 2). In the larger of these last 2 studies, Gillespie et al[28] used a pharmacist to perform medication histories and reconciliation on hospital admission and discharge, patient and provider medication counseling during hospitalization, communication with the primary care physician on discharge, and follow-up communication with the patient 2 months after discharge. This intervention reduced the odds of all hospital visits by 16% (odds ratio, 0.84; 95% CI, 0.72-0.99), including a 47% reduction in emergency department visits and an 80% reduction in drug-related readmissions in the 12 months after hospital discharge; no difference was seen in all-cause hospital readmission or mortality.[28] Koehler et al[32] reported on a similar intensive intervention but used pharmacy residents instead of licensed pharmacists. This intervention decreased 30-day emergency department visits/readmissions (10% in the intervention group vs 38.1% in the control group, $P = .04$). Common themes of these 2 successful studies included (1) limiting the intervention to elderly patients (age ≥80 and ≥70 years, respectively); (2) intensive pharmacy staff involvement, including medication history taking on admission and medication reconciliation on admission, during hospitalization, and at discharge; (3) communication with the primary care physician via direct communication or use of a template; and (4) telephone follow-up after hospital discharge. The 5 studies that demonstrated no effect on health care use had more limited roles for the intervention pharmacist[21,29,31] or used them for a more limited time during hospitalization (eg, admission or discharge only).[24,31,33]

The 6 studies that reported IT-focused medication reconciliation interventions all improved access to electronically available sources of preadmission medication information, such as ambulatory electronic medical records.[34-39] These interventions leveraged data to create a preadmission medication list and facilitated comparison of this list with admission or discharge orders to help with the medication reconciliation process. Two of 6 studies were rated as good quality.[36,39] The IT-related interventions reduced medication discrepancies (3 of 3 studies),[34,35,37] PADEs (1 of 1 study),[36] and ADEs (1 of 1 study)[38] but demonstrated no improvement/slightly increased health care use (1 of 1 study).[39] Through implementation of an electronic medication reconciliation tool and process redesign, Schnipper et al[36] decreased the average number of PADEs (1.05 per patient in the intervention arm vs 1.44 per patient in the control arm; relative risk, 0.72; 95% CI, 0.52-0.99). However, Showalter et al[39] demonstrated that implementation of an automated medication reconciliation tool on hospital discharge that also included autopopulation of other discharge instructions resulted in no difference in composite 30-day health care use (emergency department visits or readmissions) and was associated with a slight increase in 30-day hospital readmission (11.0% after the intervention vs 10.2% before the intervention, $P = .02$). The authors hypothesized that improving the discharge instructions to inform patients of worrisome symptoms may have led to higher rates of subsequent (appropriate) readmissions.[39]

Of the 5 studies that described other types of interventions, 2 provided education/feedback to staff about medication reconciliation[20,40] and 3 used a standardized medication reconciliation tool.[23,27,41] The standardized tools included a discharge report that provided a brief hospital summary detailing all medication changes that occurred during hospitalization,[27] a 6-step standardized nursing approach to medication history taking and reconciliation on admission,[41] and a standard questionnaire used by emergency department physicians on admission.[23] None of these studies were rated as good quality. These studies demonstrated improvement in medication discrepancies (4 of 4 studies)[20,23,40,41] and in PADEs (2 of 2 studies).[20,27] For example, Midlöv et al[27] described use of a physician-generated medication report for postdischarge providers that included a brief summary of the hospitalization, medications on discharge, and detailed medication changes made during hospitalization and reasons for those changes, which decreased PADEs from 8.9% before the intervention to 4.4% after the intervention ($P = .049$). The intervention was limited to elderly patients admitted from and returning to a nursing home.

Of all 26 studies, 13 focused the intervention on a high-risk subgroup of patients. This high-risk category was most commonly defined as older patients, with an age threshold from 55 to 80 years.[18,20,21,24,26-29,32,37] Other definitions of high risk included polypharmacy, with thresholds ranging from greater than 4 to

*References 18-23, 27, 29, 30, 34, 35, 37, 38, 40, 41.

Table 1. Timing and Components of Interventions for the 26 Included Studies

Source (Study Design) [Participants, No.]	Timing of Intervention	Components of Intervention	Control Group	USPSTF Quality Rating[a]
Pharmacist-Related Interventions				
Michels and Meisel,[30] 2003 (pre-post) [NR]	Preadmission Admission	Medication history taking Medication reconciliation	Usual care before intervention (nurse or physician recorded home medication list, which was used for admission orders)	Poor
Bolas et al,[21] 2004 (RCT) [162]	Admission During hospitalization Discharge	Medication history taking Medication reconciliation Patient counseling Communication with outpatient providers	Usual care (standard clinical pharmacy service, which did not routinely perform discharge counseling)	Poor
Nickerson et al,[17] 2005 (RCT) [253]	Discharge	Medication reconciliation Patient counseling Communication with outpatient providers Review appropriateness of medications	Usual care (nurse performed discharge counseling and transcribed discharge note from medical record)	Fair
Schnipper et al,[31] 2006 (RCT) [176]	Discharge	Medication reconciliation Patient counseling Communication with outpatient providers Postdischarge communication with patient	Usual care (ward-based pharmacist performed routine review of medication orders, nurse performed discharge counseling)	Good
Kwan et al,[16] 2007 (RCT) [464]	Admission	Medication history taking Medication reconciliation	Usual care (nurse conducted medication history and surgeon-generated postoperative medication orders)	Fair
Bergkvist et al,[26] 2009 (pre-post) [115]	Admission During hospitalization Discharge	Medication reconciliation Patient counseling Review appropriateness of medications	Usual care before intervention (standard care without pharmacist involvement in reconciliation or review of medications on admission or discharge)	Fair
Gillespie et al,[28] 2009 (RCT) [400]	Admission During hospitalization Discharge Postdischarge	Medication history taking Medication reconciliation Patient counseling Communication with outpatient providers Postdischarge communication with patient	Usual care (standard care without direct involvement of pharmacists at the ward level)	Good
Koehler et al,[32] 2009 (RCT) [41]	Admission During hospitalization Discharge Postdischarge	Medication history taking Medication reconciliation Patient counseling Communication with outpatient providers Review appropriateness of medications Postdischarge communication with patient	Usual care (floor nursing staff performed medication reconciliation and medication education)	Fair
Vasileff et al,[18] 2009 (non-RCT[b]) [74]	Admission	Medication history taking Medication reconciliation	Usual care (physician obtained medication history from patient and generated orders)	Poor
Walker et al,[33] 2009 (non-RCT[b]) [724]	Discharge Postdischarge	Medication reconciliation Patient counseling Communication with outpatient providers Review appropriateness of medications Postdischarge communication with patient	Usual care (nurses provided patients with printed list of medications and instructions at discharge; Medicare beneficiaries received telephone call 72 h after discharge)	Fair
Eggink et al,[25] 2010 (RCT) [85]	Discharge	Medication reconciliation Patient counseling Communication with outpatient providers	Usual care (nurses provided verbal and written instructions at discharge, physician provided patient with medication list to give to their primary care physician)	Good
Lisby et al,[24] 2010 (RCT) [99]	Admission	Medication history taking Medication reconciliation Review appropriateness of medications	Usual care (medication review by junior physician on admission and by senior physician within 24 h of admission)	Good
Mills and McGuffie,[22] 2010 (pre-post) [100]	Preadmission Admission	Medication history taking Medication reconciliation	Usual care (admitting junior physician obtained medication history and reconciled medications when patient arrived on ward from the ED)	Poor
Hellström et al,[29] 2011 (pre-post) [210]	Admission During hospitalization	Medication history taking Medication reconciliation Review appropriateness of medications	Usual care (standard care without pharmacist involvement in medication reconciliation on admission or during hospitalization, standard physician-performed medication reconciliation on discharge)	Poor

(continued)

Table 1. Timing and Components of Interventions for the 26 Included Studies (continued)

Source (Study Design) [Participants, No.]	Timing of Intervention	Components of Intervention	Control Group	USPSTF Quality Rating[a]
Pharmacist-Related Interventions				
Marotti et al,[19] 2011 (RCT) [357]	Preadmission Admission	Medication history taking Medication reconciliation	Usual care (medication history taking and prescribing performed by physician on admission)	Poor
IT Interventions				
Poole et al,[37] 2006 (pre-post) [100]	Discharge	Formation of a medication list from preexisting electronic sources Reconciliation of discharge medications with this list	Usual care before intervention (patients discharged without use of a discharge medication worksheet)	Poor
Agrawal and Wu,[34] 2009 (pre-post) [NR]	Admission	Formation of a medication list from preexisting electronic sources Reconciliation of admission orders with this list	Usual care during pilot phase (standard care without use of electronic medication reconciliation system)[c]	Poor
Murphy et al,[35] 2009 (pre-post) [NR]	Admission Discharge	Pharmacist performed medication history and reconciliation on admission Formation of a medication list from preexisting electronic sources Reconciliation of discharge medications with this list	Usual care before intervention (standard care without direct involvement of pharmacist on ward level and without electronic reconciliation)	Poor
Schnipper et al,[36] 2009 (RCT) [322]	Admission Discharge	Formation of a medication list from preexisting electronic sources Reconciliation of admission orders and discharge medications with this list Pharmacist confirmation of reconciliation at admission	Usual care (ward-based pharmacist performed routine review of medication orders, nurse performed discharge counseling)	Good
Boockvar et al,[38] 2011 (non-RCT[b]) [795]	Admission	Formation of a medication list from preexisting electronic sources Reconciliation of admission orders with this list	Usual care (no computerized availability of recent VA outpatient medication use)	Poor
Showalter et al,[39] 2011 (pre-post) [34 088]	Discharge	Formation of a medication list from preexisting electronic sources Reconciliation of discharge medications with this list	Usual care before intervention (manual completion of a printed medication reconciliation document)	Good
Other Interventions				
Varkey et al,[40] 2007 (pre-post) [102]	Admission During hospitalization Discharge	Multidisciplinary medication reconciliation using a reconciliation form on admission and discharge Education of staff on medication reconciliation, including real-time feedback on detected medication discrepancies	Usual care during "phase 1" (nurses, pharmacists, and physicians used a medication reconciliation form to collect and reconcile medications at admission and discharge, but no feedback was given)	Poor
Midlöv et al,[27] 2008 (pre-post) [427]	Discharge	Use of a physician-generated medication report to next provider of care at time of discharge that includes details of medication changes made during hospital course	Usual care before intervention (no structured way that medication changes were communicated to outpatient providers)	Poor
Chan et al,[20] 2010 (pre-post) [407]	Admission	Multidisciplinary medication history and reconciliation on admission Education of health care providers on importance of medication reconciliation via lectures, posters around hospital, and reminder notes in patient medical records	Usual care before intervention (pharmacist performed medication history on a small number of patients; this did not change during the study)	Poor
Tessier et al,[41] 2010 (pre-post) [100]	Admission	Nursing performed medication reconciliation using a 6-step instructional pamphlet	Usual care before intervention (not described)	Poor
De Winter et al,[23] 2011 (pre-post) [260]	Preadmission	ED physician performed medication history taking and reconciliation using a standardized "limited questions list" questionnaire	Usual care (admitting physician performed medication history taking and reconciliation without using a standardized tool)	Poor

Abbreviations: ED, emergency department; IT, information technology; NR, not reported; RCT, randomized controlled trial; USPSTF, US Preventive Services Task Force; VA, Department of Veterans Affairs.

[a] Please e-mail the corresponding author for further details about how quality ratings were assigned.

[b] The non-RCTs had a concurrent control group, but the sample was a convenience sample as opposed to a randomized sample.

[c] Given the poor compliance during the pilot phase, the comparison group reflected usual care before intervention.

Table 2. Study Outcomes

Source (Study Design)	Outcomes Examined[a]				Results	*P* Value or OR (95% CI)
	Medication Discrepancies	Potential ADEs	ADEs	Health Care Utilization		
Pharmacist-Related Interventions						
Michels and Meisel,[30] 2003 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				No. of defects decreased from 1.45 per order form to 0.76 in first 16 wk of implementation	<.001
					Mean No. of defects per individual drug order decreased from 0.25 to 0.12	<.001
Bolas et al,[21] 2004 (RCT)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category			No statistically significant difference between intervention and control in any outcome in this category	Decrease in drug name mismatch 10-14 d after discharge	.005
					Decrease in drug frequency mismatch 10-14 d after discharge	.004
					No difference in emergency readmission rates within 3 mo or LOS on readmission	>.05
Nickerson et al,[17] 2005 RCT)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Medication discrepancies at time of discharge were noted in 56.3% of control patients vs 3.6% of intervention patients	NR
Schnipper et al,[31] 2006 (RCT)			Statistically significant improvement with intervention vs control in at least 1 outcome in this category	No statistically significant difference between intervention and control in any outcome in this category	Preventable ADEs: 11% in control group vs 1% in intervention group 30 d after discharge	.01
					No difference in health care utilization	>.05
Kwan et al,[16] 2007 (RCT)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category.	Statistically significant improvement with intervention vs control in at least 1 outcome in this category.			40.2% of control patients had a postoperative medication discrepancy vs 20.3% in the intervention group	<.001
					29.9% of control patients had a postoperative medication discrepancy with potential for harm vs 12.9% in the intervention group	<.001
Bergkvist et al,[26] 2009 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				63.5% of control patients had ≥1 medication errors vs 26.9% of intervention patients	.01

(continued)

Table 2. Study Outcomes (continued)

Source (Study Design)	Outcomes Examined[a]				Results	*P* Value or OR (95% CI)
	Medication Discrepancies	Potential ADEs	ADEs	Health Care Utilization		
Gillespie et al,[28] 2009 (RCT)				Statistically significant improvement with intervention vs control in at least 1 outcome in this category	Intervention group had a 16% reduction in all hospital visits (quotient of 2.24 in the control group vs 1.88 in the intervention group) at 12-mo follow-up	0.84 (0.72-0.99)
					Intervention group had a 47% reduction in ED visits (quotient of 0.66 in the control group vs 0.35 in the intervention group) at 12-mo follow-up	0.53 (0.37-0.75)
					Intervention group had an 80% reduction in drug-related readmissions at 12-mo follow-up	0.2 (0.1-0.41)
					No difference in all-cause readmissions, no difference in overall survival at 12-mo follow-up	>.05
Koehler et al,[32] 2009 (RCT)				Statistically significant improvement with intervention vs control in at least 1 outcome in this category	38.1% of the control group had readmission/ED visit at 30 d vs 10% in the intervention group	.04
					Readmission/ED visit at 60 d was the same in 2 groups	>.05
					Time to readmission/ED visit was 15.7 d in the control group vs 36.2 d in the intervention group	.05
Vasileff et al,[18] 2009 (non-RCT)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category	Statistically significant improvement with intervention vs control in at least 1 outcome in this category			75.6% of usual care patients had ≥1 unintentional discrepancy vs 3.3% of intervention patients	<.05
					Of the unintentional discrepancies, 2% were felt to have potential for no harm, 40% for minor impact, 52% for significant impact, and 6% for very significant impact	IRR<0.8, except for 1 possible pairing (not specified)
Walker et al,[33] 2009 (non-RCT)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category			No statistically significant difference between intervention and control in any outcome in this category	Medication discrepancies at discharge were noted in 59.6% of control patients vs 33.5% of intervention patients	<.001

(continued)

Table 2. Study Outcomes (continued)

Source (Study Design)	Outcomes Examined[a]				Results	*P* Value or OR (95% CI)
	Medication Discrepancies	Potential ADEs	ADEs	Health Care Utilization		
					No difference in 14- or 30-d readmission rates, no difference in ED visits within 72 h	>.05
Eggink et al,[25] 2010 (RCT)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category	No statistically significant difference between intervention and control in at least 1 outcome in this category			Medication discrepancies at discharge were noted in 68% of control patients vs 39% of intervention patients	0.57 (0.37-0.88)
					Of the medication discrepancies, 29% were believed to have potential for serious harm in the control group vs 32% in the intervention group	NR (stated in text "nonsignificant")
Lisby et al,[24] 2010 (RCT)			No statistically significant difference between intervention and control in any outcome in this category	No statistically significant difference between intervention and control in any outcome in this category	No difference in LOS, time to readmission, 3-mo readmission, ED visits, visits to general practitioners, mortality	>.05
Mills and McGuffie,[22] 2010 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Medication errors decreased from 3.3 per patient before intervention to 0.04 per patient after intervention	>.05
Hellström et al,[29] 2011 (pre-post)				No statistically significant difference between intervention and control in any outcome in this category	No difference in drug-related health care utilization 3 mo after discharge	.14
Marotti et al,[19] 2011 (RCT)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Mean No. of missed medication doses during hospitalization was 3.21 in the control group vs 1.07 in the intervention group	<.001
			IT Interventions			
Poole et al,[37] 2006 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Resolution of medication discrepancies increased by 65%	<.001
Agrawal and Wu,[34] 2009 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Unintended discrepancy rate decreased from 20% before intervention to 1.4% after intervention	NR

(continued)

13 medications,[18,20,21,25,32,33,36] and having greater than 3 comorbid conditions.[18,32] Several studies included a combination of these criteria to define the intervention cohort.[18,20,21,32] Noncontrolled intervention studies described similar approaches, with pharmacist-led interventions being most common (eAppendix).

Table 2. Study Outcomes (continued)

Source (Study Design)	Outcomes Examined[a]				Results	*P* Value or OR (95% CI)
	Medication Discrepancies	Potential ADEs	ADEs	Health Care Utilization		
Murphy et al,[35] 2009 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Unintended medication discrepancies decreased from 90% to 47% on surgical floors and from 57% to 33% on medical floors	.001
Schnipper et al,[36] 2009 (RCT)		Statistically significant improvement with intervention vs control in at least 1 outcome in this category			Mean No. of potential ADEs per patient was 1.44 in the control group vs 1.05 in the intervention group	0.72 (0.52-0.99)
Boockvar et al,[38] 2011 (non-RCT)			Statistically significant improvement with intervention vs control in at least 1 outcome in this category		Intervention group experienced a 43% reduction in ADEs caused by admission prescribing changes classified as errors	0.57 (0.33-0.98)
					No difference in ADEs caused by all admission prescribing changes	1.04 (0.68-1.61)
Showalter et al,[39] 2011 (pre-post)				No statistically significant difference between intervention and control in any outcome in this category	No difference in composite outcome of 30-d readmission or ED visit from before to after intervention	.17
				Statistically significant worsening with intervention vs control in at least 1 outcome in this category	30-d readmission rate was 10.2% before intervention compared with 11% after intervention	.02
Other Interventions						
Varkey et al,[40] 2007 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Mean No. of medication discrepancies per patient at time of admission decreased from 0.5 before intervention to 0 after intervention	.018
					Mean No. of medication discrepancies per patient at the time of discharge decreased from 3.3 before intervention to 1.8 after intervention	.003
Midlöv et al,[27] 2008 (pre-post)		Statistically significant improvement with intervention vs control in at least 1 outcome in this category			8.9% of the control group had potential ADEs that would lead to required medical care (readmission to the hospital or visit to the PCP) compared with 4.4% of the intervention group	.049

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Table 2. Study Outcomes (continued)

Source (Study Design)	Outcomes Examined[a]				Results	*P* Value or OR (95% CI)
	Medication Discrepancies	Potential ADEs	ADEs	Health Care Utilization		
Chan et al,[20] 2010 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category	Statistically significant improvement with intervention vs control in at least 1 outcome in this category			Unintentional medication discrepancy rate per admission decreased from 2.6 before intervention to 1.0 after intervention	<.001
					Proportion of admissions with ≥1 clinically significant unintentional medication discrepancies decreased from 46% before intervention to 24% after intervention	.02
Tessier et al,[41] 2010 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Medication discrepancies were present in 42% of preintervention patients vs 20% of postintervention patients	.03
De Winter et al,[23] 2011 (pre-post)	Statistically significant improvement with intervention vs control in at least 1 outcome in this category				Mean No. of medication discrepancies per patient was 1.1 in the control group vs 0.6 in the intervention group	<.001

Abbreviations: ADE, adverse drug event; ED, emergency department; IRR, interrater reliability; IT, information technology; LOS, length of stay; NR, not reported; OR, odds ratio; PCP, primary care physician; RCT, randomized controlled trial.

[a] Outcomes examined intervention vs "usual care" as the comparison group (detailed in Table 1) for all studies.

COMMENT

This systematic review of hospital-based medication reconciliation practices found that various interventions, including those involving pharmacy staff, IT, and other types, successfully decreased medication discrepancies and PADEs but demonstrated inconsistent benefit on ADEs and health care utilization compared with usual care.

The medication reconciliation literature is most robust for pharmacist-related interventions, which were evaluated in 15 of 26 included studies and in 4 of 6 good-quality studies.[24,25,28,31] Several of these articles evaluated clinical outcomes, such as preventable ADEs[31] and health care utilization,[21,24,28,29,31-33] rather than solely examining process measures such as medication discrepancies. In the 2 studies[28,32] that demonstrated improvement in health care utilization, the pharmacy staff was heavily involved, performing a comprehensive medication history at hospital admission, medication reconciliation at hospital admission and discharge, patient counseling, discharge communication with outpatient providers, and postdischarge communication with the patient.

Notably, most reported pharmacist-related interventions also included the taking of an accurate medication history at the time of admission, as noted in Table 1. Errors in obtaining an accurate preadmission medication history have great potential for harm as they can propagate throughout a patient's hospitalization and after discharge. They are also the most common reason for PADEs caused by medication discrepancies.[8] Although it is difficult to distinguish the impact of an accurate medication history from the impact of successful medication reconciliation when both are included in the intervention, in reality, these 2 process steps are necessary components of the overall medication reconciliation process. It is, therefore, unrealistic to consider a successful medication reconciliation program that does not also include an initial accurate medication history from which to begin the reconciliation process.

Other common elements of the successful pharmacist-related medication reconciliation efforts included communication with postdischarge providers regarding the discharge medication regimen, including how and why the regimen differed from before admission[17,21,28,32,33] and patient education and follow-up.[17,21,26,28,31-33] The pharmacist-related interventions comprised studies that used licensed pharmacists and studies that

used less resource-intensive pharmacy staff, such as pharmacy residents[32] and pharmacist technicians,[30] demonstrating the viability of using other personnel in this role. In review of all the pharmacist- and nonpharmacist-related interventions, common elements of successful interventions were the targeting of a high-risk subgroup,[18,26-28,32,36,37] evidence of institutional support,[28,36] and performing the intervention in a defined population, for example, patients to/from a nursing home[27] or in the setting of an elective surgical admission.[19]

This review highlights the scarcity of rigorously designed studies on inpatient medication reconciliation. Only 26 studies met the inclusion criteria for this review, and of these, only 10 were randomized controlled trials,† only 1 of which was conducted at more than 1 site.[36] On quality review, only 6 of 26 studies met the criteria to be classified as good quality.[24,25,28,31,36,39] Furthermore, comparison groups in all the studies were usual care rather than alternative interventions. This is understandable given the state of medication reconciliation efforts before 2005, but it limits our ability to draw conclusions on the most effective practices of medication reconciliation. For example, because pharmacist interventions were compared only with usual care, the evidence does not definitively support pharmacist-led medication reconciliation as superior to other reported interventions. Also, usual care relating to medication reconciliation efforts has likely improved since it was first mandated by The Joint Commission, making it difficult to compare the efficacy of certain interventions in older vs newer studies. In addition, most studies investigated process measures alone, such as the presence of medication discrepancies with potential for harm, rather than clinical outcomes, which were reported in only 9 of the 26 studies.[21,24,28,29,31-33,38,39] Although process measures are easily studied, are pertinent to the issue of medication safety, and are responsive to change, it is important to distinguish between these and actual patient outcomes.

There are many reasons why it has been difficult to rigorously examine medication reconciliation efforts despite its recognized importance to patient safety. As noted in the Society of Hospital Medicine 2010 Consensus Statement,[42] medication reconciliation efforts are often resource intensive and need to overcome several challenges, including the disjointed nature of American health care, the need to maintain up-to-date and accurate medication lists across different patient care venues, and difficulty with identifying and maintaining roles and responsibility in the process. Furthermore, electronic medication reconciliation solutions are often part of larger electronic medical record systems, making it difficult to study them in isolation. Therefore, studies comparing 2 different interventions are logistically difficult, and it may be more feasible to expect comparisons of 1 intervention currently in use with that intervention plus the addition of another one.

There are several limitations of this review. Along with the lack of rigorous study design in most included studies, as discussed previously herein, it is possible (and, in fact, likely) that other medication reconciliation interventions have been implemented and studied, found to be unsuccessful, and never published. Second, many of the included studies were from outside the United States, which potentially limits its generalizability in US health care settings. Differences in patient safety culture or better access to medication information (eg, through nationalized health records) may make implementation efforts more successful in other countries than in the United States. Third, this review is intentionally limited to medication reconciliation practices within, or in transition to/from, the hospital setting and, therefore, does not include the broader scope of all medical settings, including primary care and other clinic venues.

In summary, there are limited data on the most effective practices of inpatient medication reconciliation and a lack of rigorously designed controlled studies comparing different medication reconciliation approaches with each other. In the context of these limitations, existing evidence most supports pharmacist-related interventions compared with usual care in producing the best patient outcomes, with a high degree of pharmacist or pharmacy staff involvement in all medication reconciliation–related processes being most effective. Targeting interventions to a subset of patients considered at greatest risk for an ADE, such as elderly patients, patients taking many medications, and patients with many comorbid conditions, may be of highest yield. This evidence also suggests that taking an accurate medication history and communicating with postdischarge providers are important steps, especially for reducing postdischarge health care utilization.

Future research should include randomized controlled trials when possible (and interrupted time series or "stepped wedge" designs when not possible), using rigorous outcome assessment that includes clinical and process outcomes. Studies should also compare interventions with each other or evaluate the incremental benefits of adding a second intervention to one already in use, ensuring standardized and consistent measurement methods and detailed descriptions of usual care. In addition, the Society of Hospital Medicine consensus statement on medication reconciliation recommends a set of key action items for addressing identified barriers to implementation and reporting[42]; these items should also be used in future research and quality improvement efforts. Despite the aforementioned difficulties in performing these types of rigorous studies, it should be emphasized that it is because of the resources required for successful medication reconciliation efforts that precise estimates of impact, based on rigorously conducted studies, are required. This review should help inform the development of future interventions, both for research and for institutions that want to improve medication safety during transitions in care.

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†*References 16, 17, 19, 21, 24, 25, 28, 31, 32, 36.*

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INVITED COMMENTARY

Medication Reconciliation

Moving Forward

Medication reconciliation, in some form or another, is now standard of care in most hospitals and an expectation of The Joint Commission and Accreditation Canada. In their systematic review of hospital-based medication reconciliation practices, Mueller et al[1] offer a useful reminder of the literature supporting this widespread adoption and suggest some future challenges.

Similar to many contemporary innovations in practice, medication reconciliation is not a single act or intervention. Instead, it involves a "bundle" of related critical elements applied during the high-risk period of hospitalization. Hospitals are grappling with some essential questions: What strategies for medication reconciliation are most effective? Which patients will benefit most? Is admission or discharge reconciliation most essential? Which health care professionals should lead and contribute?[2] This review illustrates that medication reconciliation is not a single intervention but rather takes place at various transitions (ie, admission, transfer, and discharge), involves a range of pharmacy expertise (ie, pharmacy technicians to clinical pharmacists), and may variously include all patients or target patients at high risk for adverse clinical outcomes (eg, adverse drug events and rehospitalizations).

The heterogeneity of medication reconciliation interventions makes it difficult to say which actions are necessary or sufficient to a good medication reconciliation process. Of the numerous critical elements of the medication reconciliation process covered in the review, 4 warrant specific mention.

1. Preadmission medication lists are critical; the more accurate and comprehensive the preadmission medication list, the easier the medication reconciliation process becomes. Access to all available medication list sources (eg, the patient, electronic medical records, and pharmacy files) facilitates a high-quality preadmission medication list.

2. Best-possible medication history requires a skilled interviewer. Although the literature does not discriminate on who does it best, it does suggest that additional training in taking a best-possible medication history may be required for any health professional to complete an efficient and comprehensive history.[3]

3. Transitions of care are vulnerable moments for medication discrepancies to occur and propagate. Identifying these time points focuses effort.

4. Targeted interventions are probably the most cost-effective. Triaging high-risk patients to interventions is essential to maximizing benefit under the constraints of finite resources. However, such targeting needs to be balanced with the expectation for safe practices that can apply to all patients in any high-reliability organization.

Many hospitals have embraced medication reconciliation by adding "check boxes" into the medical record to document that medication reconciliation has taken place. Although such efforts do accomplish compliance with The Joint Commission National Patient Safety Goals, they may fall well short of the enhanced interventions needed to improve care and reduce adverse events. Mueller et al[1] bring into focus some of the complexities to consider in achieving effective medical reconciliation. How can reconciliation be integrated from hospital admission through discharge (ie, a focus on admission alone may not be enough