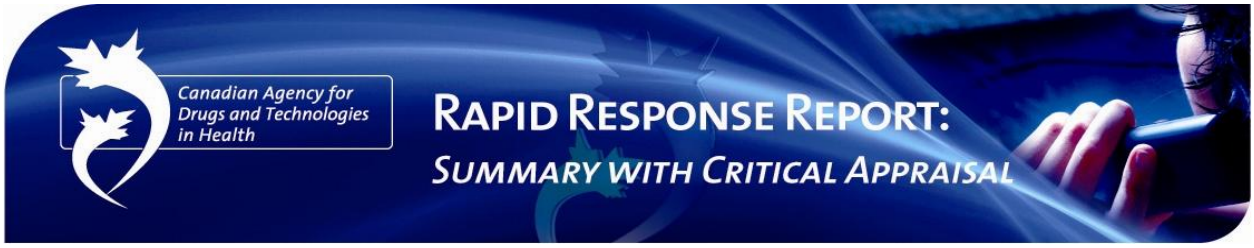


**TITLE: Medication Reconciliation at Discharge: A Review of the Clinical Evidence and Guidelines**

**DATE:** 09 April 2012

## CONTEXT AND POLICY ISSUES

Medication accuracy at transitions in care represents one of five challenging global patient safety problems identified by the World Health Organization (WHO) for intervention in their multinational, collaborative High 5s Project. This project — of which Canada was one of the initiating countries — has several aims, including the development and implementation of standardized operating protocols addressing specific patient safety problems.[1] In the hospital setting, three key transitions of care have been identified as high-risk interfaces for the occurrence of adverse medication events: 1) admission, 2) transfer (intra-institutional or extra-institutional), and 3) discharge.[2-4] The "formal process in which healthcare providers work together with patients, families and care providers to ensure accurate and comprehensive medication information is communicated consistently across transitions of care" has been defined as medication reconciliation,[2] an intervention spearheaded by the Canadian Patient Safety Institute under the banner of *Safer Healthcare Now!* to reduce preventable adverse drug events.[4]

Medication reconciliation performed at discharge specifically refers to the reconciliation or auditing of medications taken before and during admission with the medications to be taken post-discharge, in order to resolve any unintentional changes or discrepancies, such as omissions and duplications, before the patient leaves the hospital.[2] Three main sources of information are consulted to reconcile medications at discharge and create the *Best Possible Medication Discharge Plan* (BPMDP)[2]:

- *Best Possible Medication History* (BPMH) of medications taken prior to admission
- *Medication administration record* (MAR) from the last 24 hours (or most current medication profile) of medications taken during hospitalization
- Discharge medication orders for new medications to be taken post-discharge

The present review was conducted to provide a summary of the available evidence on medication reconciliation at hospital discharge to support the implementation of standard, evidence-based procedures across hospitals.

A glossary of terms can be found in Appendix 1.

## RESEARCH QUESTIONS

1. What is the clinical evidence regarding the process of medication reconciliation at discharge?

2. What are the evidence-based guidelines regarding the role of healthcare professionals in the process of medication reconciliation at patient discharge?

## KEY MESSAGE

A high number of medication discrepancies occur at discharge affecting a substantial proportion of patients, with omissions in medications representing the most common type of discrepancy noted at discharge. There is a lack of evidence on the effectiveness of medication reconciliation as a specific strategy conducted at discharge. No guidelines were identified that made specific recommendations on which member(s) of the clinical team should preferentially perform medication reconciliation.

## METHODS

### Literature Search Strategy

A limited literature search was conducted on key resources including PubMed, CINAHL, The Cochrane Library (2012, Issue 2), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and abbreviated list of major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2007 and March 12, 2012.

### Selection Criteria and Methods

One reviewer screened the titles and abstracts from the list of identified citations. Potentially relevant articles were retrieved and reviewed for final selection. Articles reporting on medication reconciliation conducted at hospital discharge were selected for inclusion, according to the criteria listed in Table 1.

**Table 1: Selection Criteria**

| | |
|---|---|
| **Population** | Adult and pediatric patients |
| **Intervention** | Medication reconciliation performed at discharge |
| **Comparator** | No medication reconciliation |
| **Outcomes** | Benefits and harms:<br>• Unintentional discrepancies<br>• Undocumented intentional errors<br>• Adverse drug events caused by medication errors<br>• Errors leading to hospitalization (readmission rates), |

| | |
|---|---|
| | usefulness/value, safety<br>• Guidelines regarding roles and responsibilities (who should be involved, what are individual roles) |
| **Study Designs** | • Health technology assessments, systematic reviews and meta-analyses<br>• Randomized controlled trials<br>• Non-randomized trials<br>• Guidelines |

**Exclusion Criteria**

Studies were excluded if they involved medication reconciliation conducted at non-acute, non-hospital-based care settings; if medication reconciliation as part of a multi-component intervention; if discharge data could not be examined in isolation in the event of studies evaluating medication reconciliation at multiple time points; or if the methods/conduct of the study was not adequately described.

**Critical Appraisal of Individual Studies**

Critical appraisal of the individual studies was performed by assessing threats to internal and external validity. No formal appraisal tool or numeric score was calculated. Strengths and limitations of the included studies were described narratively.

**SUMMARY OF EVIDENCE**

**Quantity of Research Available**

The literature search yielded 456 citations. After screening titles and abstracts, 410 articles were excluded and 46 potentially relevant reports were selected for full-text review. Of these 46 articles, 37 did not meet the inclusion criteria and were excluded, leaving a total of nine relevant reports,[5-13] all of which were non-randomized trials. No systematic reviews or randomized controlled trials were found that met the inclusion criteria.

No guidelines were identified that made specific recommendations on which member(s) of the clinical team should perform medication reconciliation. However, two references from the grey literature[2,3] did generally recommend that medication history-taking or reconciliation be performed by a trained[2] health professional; physicians, nurses, or pharmacists were cited as examples.[2,3] Tools for specifically supporting medication reconciliation at discharge[14-16] produced by the Institute for Safe Medication Practices (ISMP-Canada) are listed in the references.

The study selection process is outlined in Appendix 2.

**Summary of Study Characteristics**

Characteristics of the included studies are summarized below and detailed in Appendix 3.

*Country of origin*

Of the nine included studies, four[6,7,11,12] were from the United States, two were from Spain[8,10], and one each were from Belgium[5], Canada[13], and Solvenia[9].

*Population*

All of the included reports studied adult populations; there were no pediatric studies identified.

Two studies[5,6] specifically studied older adults. Only one study[6] included patients cared for at either an academic teaching or community hospital setting while the rest[5,7,9-13] exclusively studied patients treated at academic teaching hospitals. Most patients studied were medical admissions,[5-13] including three studies including patients with specific cardiovascular-related reasons for admission[6,7,11]; one study[11] included surgical patients.

*Standard of care provided*

Usual care in the hospitals of three[5,11,13] of the included studies involved varying degrees of medication reconciliation implementation: two performed medication reconciliation at admission only[5,11] while one[13] performed it at both admission and discharge. In all three of these studies,[5,11,13] clinical pharmacists reconciled medications.

For each of three other studies,[6,7,12] patient data were derived from a randomized controlled trial (RCT). Although the RCT source for one study,[12] did specifically evaluate a medication reconciliation intervention, whether the RCT's control group (from which the cohort study's data were derived) had been exposed to any degree of medication reconciliation was not reported.

For the three remaining studies[8-10], two[9,10] did not appear to have any formal medication reconciliation program in-place at their hospital while the status was unclear for the other study.[8]

*Comparators*

Most studies[5,6,8-13], whose aim was to quantify medication discrepancies, made use of various pieces of documentation – admission and/or discharge medication lists – with which to make cross-comparisons and ascertain discrepancies between the documents. Two studies,[9,12] however, specifically considered the pharmacist-obtained admission medication history – typically, a secondary medication history obtained following the initial physician-obtained admission history – as the criterion standard against which to make comparisons.

*Outcomes*

Eight[5,6,8-13] of the nine studies had frequency of medication discrepancies at discharge as their major outcome while the remaining study[7] performed a logistic regression analysis to examine factors associated with medication errors at various transitions of care, including at discharge.

**Summary of Critical Appraisal**

All included studies[5-13] were observational in nature, and are therefore subject to the limitations of this experimental design, namely risk of bias owing to the lack of control of potential confounders.

Three studies[5,8,11] were retrospective in design while four[9,10,12,13] were prospective. The data from three studies[6,7,12] were derived from larger RCTs, two of which were post-hoc sub-analyses[6,7] and the other[12] a prospective observational cohort study.

The generalizability of studies conducted outside of Canada[5-12] to Canadian populations may be limited due to differences in clinician scopes of practice or integration into clinical care,[8,10] or different models of care or health systems, such as in the case of the US[6,7,11,12] where financial incentives may exist for prolonging hospitalization or incurring re-admissions.[11]

The potential risk for detection bias (i.e., underdetection of discrepancies) was identified in all the included studies.[5-13] There was also some variability in the operational definition of discrepancies,[5,8,9,11,13] which could complicate the interpretation of findings generally, but particularly when comparing against a Canadian reference standard.[2]

A more detailed review of the strengths and limitations of the individual included studies is described in Appendix 4.

**Summary of Findings**

*What is the clinical evidence to support medication reconciliation at discharge?*

Medication discrepancies,[5-7,9,10,13] especially unintentional discrepancies (i.e., medication errors) were a frequent occurrence at discharge, affecting a large proportion of patients.[5,7,9,13] Omissions represented the most common type of unintentional medication discrepancy reported at discharge.[5,7-9,12,13] Of the medications implicated in medication errors at discharge, cardiovascular medications[10-13] were among the most often cited.

In some studies,[5,7,9,10] having discrepancies in the admission medication history was associated with having medication errors[7,9,10] or discrepancies[5] at discharge. However, the absolute number of admission medications was not associated with having medication discrepancies at discharge in one study.[6] Two other studies[7,12] found that the number of changes made to medications during admission was positively associated with the occurrence of medication errors at discharge.

Age was found to be positively associated with discharge discrepancies in two studies[5,9], while an inverse association was found between age $\geq$ 85 years and the risk for potential adverse drug events in another study.[12]

Findings from the individual studies are presented in greater detail in Appendix 5.

*What are the evidence-based guidelines regarding the role of healthcare professionals in the process of medication reconciliation at patient discharge?*

No guidelines were identified that made specific recommendations regarding which member(s) of the clinical team should perform medication reconciliation. However, two references from the grey literature[2,3] made a general recommendation that medication history-taking or reconciliation be performed by a trained[2] health professional; physicians, nurses, or pharmacists were cited as examples.[2,3]

### Limitations

One of the nine included studies was conducted in Canada.[13] It is therefore uncertain to what extent the findings from the other included studies would apply to a Canadian population.

This review was limited to examining medication reconciliation occurring at hospital discharge; however, admission and transfer (intra-institutional or extra-institutional) represent two other high-risk interfaces in the hospital setting for the occurrence of medication errors.

An important limitation inherent with medication reconciliation research is the absence of a medication history criterion or gold standard[11,12] against which to compare other medication histories or orders. Nonetheless, it is commonly assumed that pharmacists[5,12,17,18] represent the best health human resource for capturing accurate, complete medication histories. No guidelines were found that made specific recommendations about which health professional(s) should preferentially perform medication reconciliation; however, medication reconciliation is often referred to as a multidisciplinary activity in scope[2], likely a reflection of its importance across multiple transitions of care.

Medication reconciliation, despite being an intervention to improve patient safety, may be considered a fairly jargonistic or arcane activity particularly to the uninitiated, which may explain some of the variability seen in the operational definitions of discrepancy. [5,8,9,11,13]

## CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

Medication reconciliation can be a resource-intensive activity that is ideally conducted at several high-risk transition points to reduce the risk of medication errors (including the propagation of unresolved errors) during hospitalization.[2] It is a patient safety activity that would seem to demand a high degree of multidisciplinary cooperation or collaboration to maximize the impact from the effort. However, there appears to be a lack of evidence on the effectiveness of medication reconciliation as a specific strategy conducted at discharge. Notwithstanding the included studies' inherent design limitations for assessing attribution, the outcomes reported – medication discrepancies – were only surrogates for potential, not actual, harms (e.g.,re-admissions, morbidity, death). Therefore, the actual impact on the patient from medication discrepancies at discharge is uncertain.

Discharge has been identified as one of several high-risk care interfaces in the hospital, where medication reconciliation aims to reconcile pre-admission and in-hospital medications with the post-discharge medication regimen before a patient is discharged, and in so doing, reduce the risk of preventable adverse medication events.

In this review, medication omissions represented the most common type of medication discrepancy encountered at discharge and were often related to medication discrepancies occurring earlier in the course of hospitalization, particularly at admission.

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## Appendix 1: Glossary of Terms from *Safer Healthcare Now!*[2]

**Admission Medication Orders:**
"Prescriber-recorded admission medication orders documented within 24 hours from the time of admission to a healthcare facility." (p. 7)

**Adverse Drug Event:**
"An injury from a medicine or lack of an intended medicine. Includes adverse drug reactions and harm from medication incidents." (p. 7)

**Best Possible Medication History:**
"History created using 1) a systematic process of interviewing the patient/family; and 2) a review of at least one other reliable source of information to obtain and verify all of a patient's medication use (prescribed and non-prescribed). Complete documentation includes drug name, dosage, route and frequency." (p. 7)

**Discrepancies**

**Intentional**
***Documented:***
"An *intentional* discrepancy is one in which the prescriber has made an intentional choice to add, change, or discontinue a medication and their choice is clearly *documented*. This is considered 'best practice' in medication reconciliation." (p. 7)

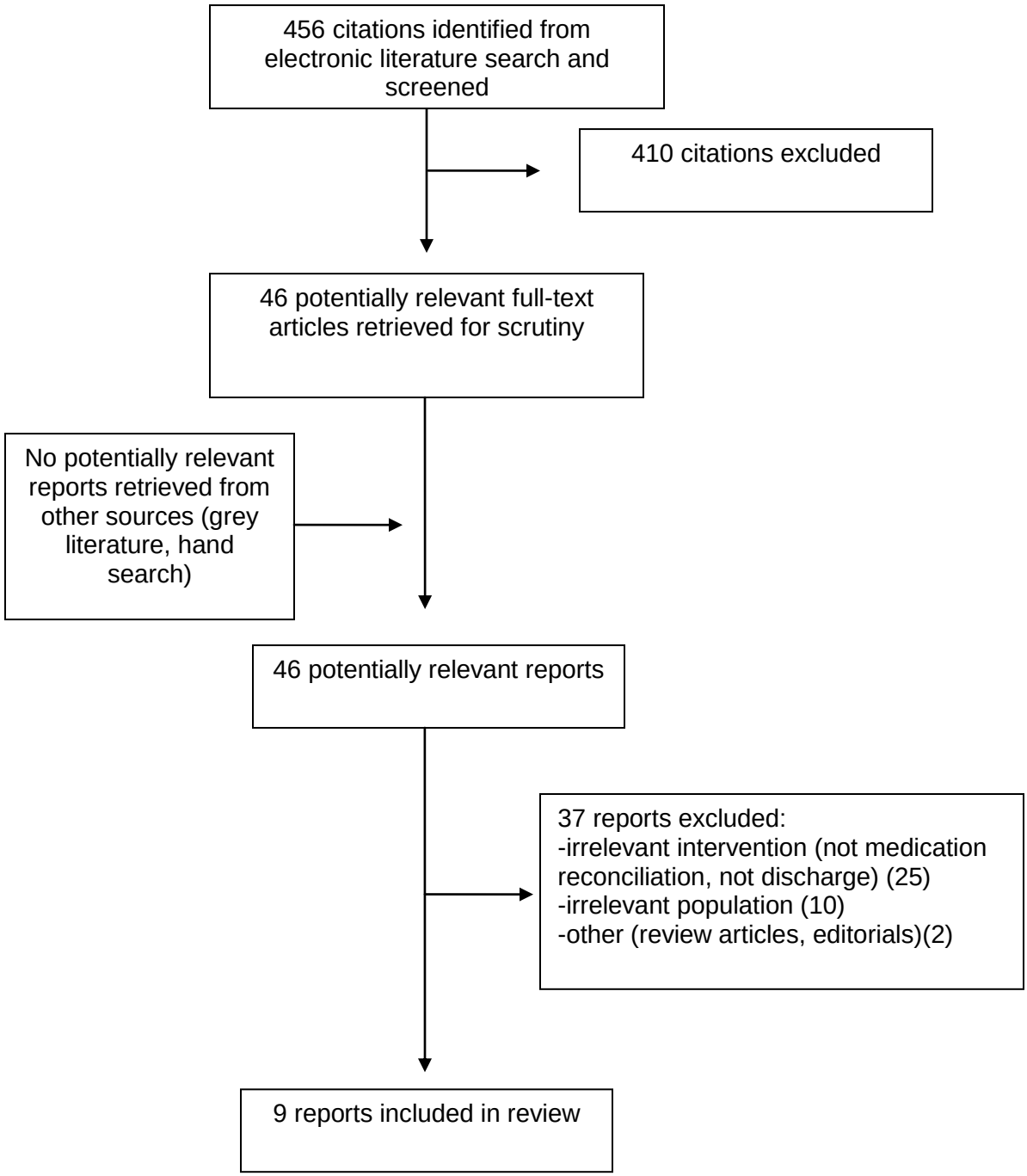
***Undocumented:***
"An undocumented intentional discrepancy is one in which the prescriber has made an intentional choice to add, change, or discontinue a medication, but this choice is *not* clearly documented." (p. 8)

**Unintentional:**
"An unintentional discrepancy is one in which the prescriber unintentionally changed, added, or omitted a medication the patient was taking prior to admission." (p. 8)

**Best Possible Medication Discharge Plan:**
"A Best Possible Medication Discharge Plan (BPMDP) is created using the Best Possible Medication History (BPMH), the last 24-hour medication administration record (MAR) or most up-to-date medication profile as references. The BPMDP evaluates and accounts for:

- New medications started in hospital
- Discontinued medications (from BPMH)
- Adjusted medications (from BPMH)
- Unchanged medications that are to be continued (from BPMH)
- Medications held in hospital
- Non-formulary/formulary adjustments made in hospital
- New medications started upon discharge
- Additional comments as appropriate – e.g., status of herbals or medications to be taken at the patient's discretion" (p. 27)

**Appendix 2: Selection of Included Studies**



**Appendix 3: Summary of Study Characteristics**

| First Author, Publication Year, Country | Study Design | Population | Intervention | Comparator | Outcomes |
|---|---|---|---|---|---|
| Cornu et al., 2012,[5] Belgium | Retrospective, single centre, cohort study (chart review) | Patients ≥ 65 years old, taking ≥ 1 medication prior to admission to an acute geriatric department of a Belgian university hospital | Usual care; no medication reconciliation implemented at discharge | Admission medication history (completed by clinical pharmacist)<br><br>Discharge summary letter | For discharge specifically: Frequency of medication discrepancies at discharge based on a comparison of the admission medication history (completed by the clinical pharmacist) with the discharge summary letter |
| Foust et al., 2012,[6] United States | Post-hoc descriptive analysis | Older adults with heart failure originally enrolled in a US multi-centre RCT comprising a network of six local academic or community-based hospitals | Patient data for this sub-analysis were derived from an RCT in transitional care led by an advanced practice nurse, who was not directly involved in preparing discharge documentation. | Hospital discharge summary<br><br>Patient discharge instructions | Frequency and type of medication discrepancies at discharge based on a comparison of the hospital discharge summary and the patient discharge instructions |
| Salanitro et al., 2012,[7] United States | Post-hoc cross-sectional sub-analysis | Patients ≥ 18 years old admitted with acute coronary syndromes or acute decompensated heart failure originally enrolled in a US multi-centre RCT, who received pharmacist-assisted medication reconciliation during hospitalization at one of two unaffiliated US-based academic | Patient data for this sub-analysis were derived from the intervention arm of an RCT of a pharmacist intervention for low literacy in cardiovascular disease (PILL-CVD); only data from the RCT's intervention group were used, in which | N/A | Identification of patient- and medication-related factors associated with errors in pre-admission medication lists and admission medication orders, and their association with medication errors at discharge |

| First Author, Publication Year, Country | Study Design | Population | Intervention | Comparator | Outcomes |
|---|---|---|---|---|---|
| | | hospitals | all patients received medication reconciliation by a pharmacist while in hospital. | | |
| Herrero-Herrero et al., 2011,[8] Spain | Retrospective, descriptive chart review | Internal medicine patients discharged from a Spanish tertiary care university teaching hospital, without selection criteria | Usual care (unclear whether a formal medication reconciliation program in-place; report would suggest that issues around medication management fall under the sole purview of physicians.) | Pre-admission medication history (completed by physician)<br><br>Discharge medication list | Frequency of medication discrepancies between the discharge medications and the pre-admission medication lists |
| Knez et al., 2011,[9] Slovenia | Prospective, descriptive cross-sectional observational study | Patients $\geq$ 18 years old, taking $\geq$ 1 drug admitted to a medical ward in a teaching hospital in Slovenia specializing in pulmonary and allergic diseases with length of stay > 3 days | Usual care plus pharmacist-obtained pre-admission medication list in all study patients (in addition to the usual physician-obtained medication history upon admission) | Pharmacist-obtained pre-admission medication list served as criterion standard<br><br>Discharge summary letter | For discharge specifically: Frequency of medication discrepancies at discharge based on a comparison of the pre-admission medication list (completed by the clinical pharmacist) with the discharge summary letter |
| Climente-Marti et al., 2010,[10] Spain | Prospective, observational study | Internal medicine patients on chronic medication admitted to a Spanish public tertiary care teaching | Usual care plus medication reconciliation at admission and discharge (for all | Pre-admission medication list<br><br>Inpatient orders | For discharge specifically: Frequency of medication discrepancies at discharge based on a comparison of the pre-admission medication list and the |

| First Author, Publication Year, Country | Study Design | Population | Intervention | Comparator | Outcomes |
|---|---|---|---|---|---|
| | | hospital with length of stay > 48 hours | study patients) performed by team of physician and pharmacist | | admission orders with the discharge summary letter |
| Tschantz Unroe et al., 2010,[11] United States | Retrospective cohort study (chart review) | Patients admitted to either general medicine, cardiology, or general surgery services of a large, US tertiary care academic teaching hospital | Usual care (included medication reconciliation by clinical pharmacists during admission, but not at discharge) | (Reconciled) admission medication list<br><br>Discharge medication list | For discharge specifically: Frequency of medication differences at discharge based on a comparison of the patient's discharge medications list and the dictated discharge summary against the (reconciled) admission medication list |
| Pippins et al., 2008,[12] United States | Prospective, observational cohort study | Patients comprised the control group from a cluster-RCT at two large, US academic hospitals, which evaluated the impact of a computer-aided medication reconciliation intervention | Patient data for this study were derived from the control arm of an on-going RCT of a computer-aided medication reconciliation intervention; unclear whether control-arm patients were exposed to any form of medication reconciliation in the original RCT. | Pharmacist-obtained ("gold standard") pre-admission medication history<br><br>All relevant admission and discharge documents | Number of unintentional medication discrepancies with potential for causing harm (i.e., potential adverse drug events or PADEs per patient) |
| Wong et al., 2008,[13] Canada | Prospective, observational study | Patients admitted to the general internal medicine service at the Toronto General Hospital, a large, tertiary care academic | Usual care (included medication reconciliation by clinical pharmacist, when available, at | Best Possible Medication Discharge List (BPMDL; prepared by clinical pharmacist; | Primary outcome was the incidence of at least one unintentional medication discrepancy at discharge based on a comparison of the discharge medication orders and discharge |

| First Author, Publication Year, Country | Study Design | Population | Intervention | Comparator | Outcomes |
|---|---|---|---|---|---|
| | | teaching hospital | admission and prior to discharge) | criterion standard)<br><br>Discharge medication orders<br><br>Discharge summary | summary with the BPMDL. |

N/A=Not applicable

**Appendix 4: Summary of Critical Appraisal**

| First Author, Publication Year, Country | Strengths | Limitations |
|---|---|---|
| Cornu et al., 2012[5] | • Exclusion criteria clearly described.<br>• Vulnerable population studied: geriatric<br>• A study pharmacist independently assessed the concordance between physician- and pharmacist-obtained admission medication histories. | • Single centre<br>• Objectives do not clearly convey that discrepancies were to be evaluated at discharge.<br>• Vague operational definition for discrepancy; unable to ascertain concordance with the Canadian reference standard[2]<br>• Possible risk of detection bias (for under-detection): Unclear how many (and which) source documents were used to assess medication discrepancies at discharge.<br>• Possible risk of recall bias: Pharmacist conducted the admission medication history after the physician completed his/hers.<br>• Belgian population studied; results may not be generalizable to other countries |
| Foust et al., 2012[6] | • Description of frequency and type of discrepancies found on specific discharge documents<br>• Multi-centre (six sites)<br>• Vulnerable population studied: older adults | • Potential historical bias: data analyzed pre-dated a national medication reconciliation initiative<br>• Potential detection bias (for under-detection): Only the hospital discharge summary and patient discharge instructions were compared for discrepancies; no pre-admission medication source documents were examined.<br>• Data collected from six hospital sites with variables discharge practices<br>• Unclear whether one or two reviewers were involved in all aspects of determining which patient records to include (i.e., two reviewers were specifically involved in assessing illegibility-related exclusion decisions). |
| Salanitro et al., 2012[7] | • Multi-centre (two sites)<br>• Three time points analyzed (i.e., pre-admission | • Pharmacists who conducted medication reconciliation also adjudicated the clinical relevance of medication |

| First Author, Publication Year, Country | Strengths | Limitations |
|---|---|---|
| | medication list, admission orders, discharge medication orders)<br>• Clearly described objectives, methods | errors.<br>• No adjustments made in regression analysis for multiple sites, raters.<br>• Findings may not be generalizable to broader general medical population taking less medication, or smaller community or predominantly paper-based hospitals.<br>• Sample population for analysis was derived from the intervention arm of an RCT with a modest overall consent rate (41%). |
| Herrero-Herrero et al., 2011[8] | • Single rater<br>• Charts reviewed were unselected; only those with incomplete medication history data were excluded | • Spanish population studied; results may not be generalizable to other countries<br>• No clinical pharmacist involvement in the care process<br>• Undefined terms: 'permanent' versus 'temporary' medications<br>• Inconsistencies in the definitions of unintentional and intentional discrepancies compared with those described in the Canadian reference standard[2]<br>• Discharge reports included those of patients who were hospitalized more than once<br>• Possibility of a detection bias resulting in underdetection of discrepancies<br>• Possibility of confirmation bias related to a belief in the ability of physicians to detect their own medication errors |
| Knez et al., 2011[9] | • Study patients were randomly selected (i.e., by random generated numbers)<br>• Independent panel rated the clinical significance of medication errors | • Several possible sources of detection bias: 1) 'only the most significant [discrepancies] were recorded'; 2) prescribing physicians were asked to clarify intent of discrepancies; 3) no distinction was made between intentional, *undocumented* versus intentional, *documented* discrepancies (In Canada, the former would have been considered a medication error[2] while |

| First Author, Publication Year, Country | Strengths | Limitations |
|---|---|---|
| | | in this study it was not.).<br>• Slovene population studied; results may not be generalizable to other countries.<br>• No definition of individual ratings of clinical significance provided<br>• No details given on types of medications involved in medication errors |
| Climente-Marti et al., 2010[10] | • Pre-admission medication list was synthesized using ≥ 2 sources of data<br>• Vulnerable population studied: predominantly elderly patients of mean age > 75 years | • Potential generalizability issues: 1) inclusion of patients who were willing to consent to participate in the study, and 2) Spanish population studied (uncertain whether findings can be applied to other countries).<br>• Non-prescription medications or products (i.e., vitamins, herbal or nutritional supplements) were not studied<br>• Potential detection bias: prescribing physicians were asked to clarify intent of discrepancies<br>• Unclear what the pharmacist role was in the pharmacist-physician team approach to the medication reconciliation process; unclear who synthesized the pre-admission medication list<br>• Unclear whether prescribing physician could have been involved in identifying medication discrepancies between pre-admission medication list and his/her admission orders<br>• The study physician and pharmacist rated the clinical impact of medication errors (i.e., lack of independent rating) |
| Tschantz Unroe et al., 2010[11] | • Charts were randomly selected using a computerized random number generation program.<br>• Clear policy and training was in place for conducting medication reconciliation (at admission, but not at discharge) | • Narrower definition of 'discrepancy' used compared with the Canadian reference standard[2] where only *unintentional* (and not also *intentional undocumented*) discrepancies were considered.<br>• Potential detection bias: Pharmacist conducting |

| First Author, Publication Year, Country | Strengths | Limitations |
|---|---|---|
| | • Data abstraction included a reliability assessment to ensure concordance between the data-entry of the two abstractors.<br>• Use of published classification systems for evaluating high-risk nature of medications. | medication reconciliation also adjudicated clinical relevance of discrepancies found; only clinically-relevant discrepancies were documented in patient's chart.<br>• No medication reconciliation service implemented at discharge, which prevents the use of 'discrepancy' to assess inconsistencies noted between discharge medication lists and dictated discharge summaries; alternatively, 'differences' was used. |
| Pippins et al., 2008[12] | • Multi-centre (two sites)<br>• Distinguished between intentional versus unintentional medication discrepancies<br>• Pre-admission medication history was obtained by following a formal protocol, which mandated the use of multiple information sources<br>• Blinded adjudication panel (rotating team of two physicians) for assessing discrepancies with formal adjudication protocol<br>• Weekly quality assurance meetings to ensure consistency in study procedures between the two hospital sites and study personnel<br>• Inter-rater reliability assessments conducted to evaluate consistency of pre-admission medication histories taken by the two study pharmacists and of the assessments made by physician-adjudicators<br>• Reported on differences between excluded and included patients | • Lack of information about participants, who were derived from the control group of an RCT.<br>• Subjective categorical rating system (but informed by some objective criteria) used by study pharmacists to evaluate a patient's understanding of their pre-admission medications.<br>• Findings may not be generalizable to non-academic hospital centres, or to services other than general medicine.<br>• Possibility of a selection bias for patients with longer lengths of hospital stay and greater polypharmacy compared with excluded patients.<br>• Possibility of a detection bias, where the number of potential adverse drug events (PADEs) per patient may have been overestimated because of the afore-mentioned potential selection bias.<br>• Only PADEs were measured, not actual. |
| Wong et al., 2008[13] | • Canadian study<br>• Clearly described exclusion criteria<br>• Use of a classification system to categorize discrepancies<br>• Blinded assessment of the potential clinical impact of (actual) unintentional discrepancies was performed by | • Modification of the established (Canadian) definition[2] for *unintentional discrepancy* to enable a subdivision of the term using 'actual' or 'potential' as a modifier. This may hinder interpretation in the context of other trials using more traditional typology.<br>• Possible sources of detection bias, such that |

| First Author, Publication Year, Country | Strengths | Limitations |
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| | three independent assessors using an adapted published process with clearly described assumptions; a majority consensus was required for categorizing a discrepancy; inter-rater reliability was evaluated.<br>• A power calculation was performed to determine the sample size needed. | medication discrepancies may have been underreported: 1) a Best Possible Medication History (BPMH) was not always among the documents available for reconciling medications at discharge; 2) the prescribing physician was consulted to clarify whether a discrepancy was intentional or unintentional.<br>• The findings may not be generalizable to non-academic non-tertiary care centres or to patients who were not discharged home. |

**Appendix 5: Summary of Findings**

| First Author, Publication Year, Country | Main Study Findings | Authors' conclusions |
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| Cornu et al., 2012[5] | For discharge component only:<br>Following a review of the pharmacist-obtained medication history and the discharge letter, a total of 554 discrepancies were found at discharge, with a median of 3 per patient (range: 0-10).<br>≥ 1 discrepancy was noted at discharge for 172 patients (86.4%), with drug omission (57%) representing the most common type of discrepancy noted at discharge.<br>A total of 278 (40.8%) of the original 681 discrepancies discovered on admission were noted at discharge.<br>Discrepancies with the physician-obtained admission medication history were responsible for half (50.2%) of the discrepancies found at discharge.<br>In the case of omitted drugs at admission, 165 (47.6%) were either not prescribed or prescribed incorrectly at discharge. Another 35.1% of discrepancies noted at discharge were comprised of dosing or frequency discrepancies, incorrect medications or typos originating from the medication history.<br>Following multivariate logistic regression, age [OR: 1.10 (95% CI 1.02, 1.19)] and the number of correctly identified drugs in the pharmacist-obtained medication history [OR: 1.19 (95% CI 1.01, 1.41)] were significant predictors of having ≥1 discrepancies at discharge. | "Accurate and complete medication histories [at admission] are of utmost importance, as at least half of all discrepancies at discharge originate from discrepant medication histories."(p.9) |
| Foust et al., 2012[6] | A total of 198 discharge records were included for analysis, representing 162 patients.<br>71.2% (141/198) of discharges had an average of 1.3 problems per discharge, with 76.6% being associated with ≥ 1 high-risk medication*.<br>Medication discrepancies (58.9%) were most common type of discharge-related problem encountered, with inconsistent dosages and/or frequencies (62.7%) representing the most common type of medication-related | "…need to consider hospital patient instructions and discharge summaries as two strategic documents that must be reconciled to provide continuity of medication information to two distinct groups (i.e., patients and their family caregivers and post-hospital clinicians)."(p.32) |

| First Author, Publication Year, Country | Main Study Findings | Authors' conclusions |
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| | discrepancy.<br>There was no difference found in the number of admission medications in patients with discharge problems (mean: 7) versus those without (mean: 6.6) (p=0.694).<br><br>**High-risk medications included cardiovascular, anticoagulant, anti-infective, analgesic, anti-epileptic, and corticosteroid drugs.* | |
| Salanitro et al., 2012[7] | At discharge, 40% (158/405) of patients had a medication order error, including 32% with a clinically relevant error.<br>The most common medication errors at discharge were related to commission (35%), omission (25%), dosing (18%), frequency (15%), and substitutions (5%).<br>Patients who lived alone [IRR: 0.61 (95% CI 0.41, 0.90)] or who had cognitive impairments [IRR: 0.47 (95% CI 0.27, 0.82)] had a lower number of clinically-relevant discharge medication errors.<br>Having errors in the pre-admission medication list was associated with clinically-relevant errors in the discharge medication list [IRR: 1.31 (95% CI 1.19, 1.45)]<br>The number of medication changes made during hospitalization was associated with clinically relevant errors in discharge medications.[IRR: 1.10 (95% CI 1.05, 1.15)] | "…errors in compiling the pre-admission medication list lead to errors in admission orders as well as discharge medications and are the strongest predictor of clinical relevant medication errors throughout hospitalization."(p.8) |
| Herrero-Herrero et al., 2011[8] | 954 (93%) discharge reports were deemed complete.<br>Medication discrepancies between admission and discharge were found in 832 (87.2%) discharge reports.<br>Unintended discrepancies numbered 52 (5.4%), of which errors of omission were the most frequent type (84.6%).<br>Four cases of unintended discrepancies were associated with rehospitalizations. | "…in our opinion, appropriate routines for ensuring an accurate collection of medication history and the methodical completion of the medication list at discharge, when performed by trained internists, are important factors for an adequate medication reconciliation process, at least in hospital settings similar to that in which our work was carried out."(p.47) |
| Knez et al., 2011[9] | 101 patients were studied; median age of 73 years (IQR: 65-79); 57.4% were male; median number of pre- | "…admission and discharge from hospitals were shown to produce a large number of discrepancies |

| First Author, Publication Year, Country | Main Study Findings | Authors' conclusions |
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| | admission medication = 6 (IQR: 4-9)<br>Compared with the pre-admission list, 566 (75.8%) medications prescribed at discharge were discrepant, of which 369 (65.2%) were medication errors, with 58.0% being rated as clinically important errors. Most commonly recorded medication errors at discharge were drug omissions (40.4%).<br>Median number of medication errors/patient = 3, with 71.3% of patients having $\geq$ 1 clinically important medication error.<br>Factors associated with medication errors at discharge included age (r=0.235, p=0.018), number of pre-admission drugs (r=0.660, p<0.001), and number of discrepancies recorded in the medication history (r=0.413, p<0.001) or in the inpatient orders (r=0.755, p<0.001); except for age, these same factors were also associated with clinically important medication errors. | in patients' drug therapy… discrepancies and errors in the medication history [at admission] and in in-patient therapy led to a higher number of errors in further steps [i.e., at discharge]."(p.S65) |
| Climente-Marti et al., 2010[10] | 120 patients were studied; mean age = 76.0 years with 48.3% were aged > 80 years; 65.0% had a moderate to high level of dependency; patients had a mean of 3.4 co-morbid diseases while 75% of patients were taking $\geq$ 5 chronic medications prior to admission.<br>A total of 509 discrepancies were found in 109 patients (mean=3.5 per patient), with 20.7% of discrepancies occurring at discharge. Medication errors, however, were more common at discharge (24.5%) than at admission (3.4%). The three most common classes of medications associated with medication errors were: blood and hematopoietic organ (30%), cardiovascular (20%), and gastrointestinal (20%) drugs.<br>'Medication discrepancies on admission' was the only risk factor significantly associated with the occurrence of reconciliation errors at discharge according to univariate logistic regression [Adjusted OR: 1.21 (95% CI 1.01, 1.44), p=0.007] | "… interventions that aim to improve the safety of medication at transitions in care should focus first and foremost on preventing reconciliation errors at discharge."(p.1752) |

| First Author, Publication Year, Country | Main Study Findings | Authors' conclusions |
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| Tschantz Unroe et al., 2010[11] | A total of 205 patient charts were included, 27 of whom did not have any recorded pre-admission medications. Patients had a mean age of 59.9 years, were predominantly male (57%), white (60%), with a mean of 4.2 co-morbid conditions at admission. The majority of patients was living at home prior to admission (80%) and had an average length of hospitalization of 4.5 days.<br>At discharge, 196/205 [96%, (95% CI 93, 98)] of patients were found to have ≥ 1 medication difference (mean: 5.4; range: 0-18) based on their admission medications listing.<br>A total of 1102 medication differences were noted at discharge, with cardiovascular medications comprising the most frequently involved class (27%). The two most frequent types of differences encountered at discharge were medication additions (51%) or discontinuations (28%). Differences between medication discharge lists and dictated discharge summaries were noted for 35% of patients. | "… medication differences at discharge were prevalent for adult patients admitted to the general medicine, cardiology, and general surgery services… Medication reconciliation processes have a high potential to identify clinically important discrepancies for all patients."(p.125) |
| Pippins et al., 2008[12] | A total of 180 patients were studied.<br>While fewer potential adverse drug events (PADEs) arose from errors in reconciling pre-admission medications with discharge medication orders (2%), the majority of PADEs occurred at discharge (75%). [The majority (72%) of PADEs occurred in association with errors in the pre-admission medication history taken by the medical team.]<br>Omissions (60%) were the most common cause of unintentional discrepancies occurring at admission or discharge.<br>Cardiovascular drugs (20%) were the most common class of medications implicated in all PADEs.<br><br>Several predictors were associated with PADEs in general (at $p<0.05$ level) including:<br>Age ≥ 85 years [RR: 0.34 (95% CI 0.16, 0.73)]<br>≥ 4 high-risk* pre-admission medications [RR: 3.00 (95% | "Based on the results of this study, interventions to improve medication safety at transitions in care should focus first and foremost on gathering accurate pre-admission medication information, and secondly on preventing reconciliation errors at discharge."(p.1419) |

| First Author, Publication Year, Country | Main Study Findings | Authors' conclusions |
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| | CI 1.29, 7.00)]<br>Medication changes from pre-admission to discharge:<br>6 to 9 changes [RR 3.22 (95% CI 1.76 to 5.89)]<br>10 to 13 [RR 3.21 (95% CI 1.58 to 6.49)]<br>14 to 28 [RR 4.06 (95% CI 2.13 to 7.74)]<br>Medium to low patient understanding of pre-admission medications [RR: 1.65 (95% CI 1.14, 2.39)]<br>Family member/caregiver as source of pre-admission medication information [RR: 1.62 (95% CI 1.10, 2.38)]<br><br>**High-risk medication classes most likely to cause PADEs: gout medications, muscle relaxants, hyperlipidemic agents, antidepressants, and respiratory medications.* | |
| Wong et al., 2008[13] | A total of 150 patients were studied. Mean age was 65.9 years with equal distribution of gender (Female: 50.7%). Median length of hospital stay was 5.5 days (range: 3-47) The median number of prescription medications on discharge was 4 (range: 0-18). The primary diagnosis associated with the hospitalization was infection (24.7%) followed by gastrointestinal bleeding or other gastrointestinal disease (12.0%) and congestive heart failure (12.0%).<br>Unintentional discrepancies (actual or potential) were noted in 106 patients.<br>The total number of discrepancies per the Best Possible Medication Discharge List (BPMDL) was 322 (25.7%), 277 of which were unintentional discrepancies (actual: 105, potential: 172).<br>Omission of a medication (22.9%) or incomplete prescription requiring clarification (49.5%) accounted for the majority of actual unintentional discrepancies.<br>Cardiovascular (26.7%) and gastrointestinal medications (21.9%) comprised the medications most commonly | "In comparison [with admission medication reconciliation] discharge medication reconciliation requires multiple comparisons between different pieces of information, including medications on the BPMH, medications prescribed in the hospital (adjusted, new, discontinued), unchanged home medications, and medications to be started at discharge, which makes this process complex… This study highlights the need for structured medication reconciliation to prevent discharge discrepancies."(p.1376-8) |

| First Author, Publication Year, Country | Main Study Findings | Authors' conclusions |
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| | associated with actual unintended discrepancies.<br>Of the actual unintentional discrepancies, 31% were categorized as having potential to cause 'possible' or 'probable' patient discomfort and/or clinical deterioration, affecting 22 (14.7%) of patients. | |

CI: Confidence interval; IQR: interquartile range; IRR: incidence rate ratio; OR: odds ratio; RR: relative risk