Effect of Medication Reconciliation on Unintentional Medication Discrepancies in Acute Hospital Admissions of Elderly Adults: A Multicenter Study

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OBJECTIVES: To investigate the effect of pharmacy-based medication reconciliation on the frequency of unintentional medication discrepancies in acutely admitted individuals aged 65 and older.

DESIGN: Multicenter intervention study with pre–post design.

SETTING: Twelve Dutch hospitals.

PARTICIPANTS: One thousand five hundred forty-three individuals aged 65 and older with an acute hospital admission through the emergency department.

MEASUREMENTS: The intervention consisted of the Best Possible Medication History (BPMH), based on combining information from the community pharmacy record, the information provided by a structured interview with participants about their medication use, and medication containers. In nine hospitals, pharmacy technicians obtained the BPMH, and in three hospitals, a mixed model was used (physicians or pharmacy technicians obtained the BPMH). Primary outcome measure was the proportion of participants with one or more unintentional medication discrepancies. The primary outcome measure was stratified according to type of intervention (pharmacy based vs mixed model).

RESULTS: The proportion of participants with one or more unintentional medication discrepancies was reduced from 62% to 32% [odds ratio (OR) = 0.29, 95% confidence interval (CI) = 0.23–0.37]. These results remained statistically significant after adjustment for type of department and hospital (OR = 0.20, 95% CI = 0.15–0.26), and this effect remained stable for 6 months. Stratified analysis showed that no effect from the intervention was evident in the three hospitals with a mixed-model intervention, in contrast to the hospitals with a pharmacy-based intervention. The medication discrepancy types “omission” and “dosage or strength” occurred most frequently and were the main types that the intervention influenced.


Key words: medication reconciliation; pharmacy-based; medication safety

In 2006, the Institute of Medicine issued the report Preventing Medication Errors, in which one of the recommendations to improve medication and safety is the performance of medication reconciliation at all transition points in health care.¹ The report also states that more research is necessary, especially on the occurrence and prevention of medication errors at transitions in care.

A systematic review of studies on medication history discrepancies at hospital admission showed that 27–54% of participants had at least one medication history error and that 19–75% of these discrepancies were unintentional.² Medication errors in admission medication histories are associated with older age and number of medications.

Because many people are hospitalized acutely through the emergency department (ED), medication history taking starts there and should be performed adequately, yet

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Dutch CBO WHO High 5s Study Group members are in the Appendix.

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several studies show that medication history lists obtained in EDs are not accurate. One or more discrepancies occurred in 37–87% of participants.

When examining strategies to improve medication history taking, electronic medication reconciliation and medication reconciliation (generally defined as the process of obtaining and maintaining a complete and accurate list of the current medication use of an individual across the healthcare settings) performed by pharmacists instead of physicians are effective. Pharmacy-based medication reconciliation has been shown to be one of four cost-effective strategies (out of a total of 21) to improve patient safety. When pharmacists perform medication reconciliation in the ED, a recent study including 3,594 medication histories showed that 59% of the medication histories that pharmacists took were different from those that physicians took. Another study in the ED showed that medication reconciliation by pharmacy technicians was comparable to that of pharmacists when examining the mean number of discrepancies per patient (0.24 vs 0.25 for prescription drugs and 0.15 vs 0.14 for over-the-counter products). For pharmacy technicians and pharmacists, the mean number of discrepancies per patient was significantly lower than the national average (0.54). A recent review on the effect of medication reconciliation concluded that studies consistently showed reductions in medication discrepancies, potential adverse drug events, and adverse drug events. The effect on postdischarge healthcare usage was still uncertain.

In summary, evidence clearly shows the importance of pharmacy-based medication reconciliation in the ED, yet several barriers to implementation of patient safety interventions still exist. To address these continuing concerns about patient safety around the world, the World Health Organization (WHO) launched the High 5s program in 2006. The High 5s name derives from the project’s original intent to significantly reduce the frequency of five challenging patient safety problems in five countries over 5 years (2010–2015) by implementing and evaluating standard operating procedures (SOPs). The global learning community consists of nine participating countries. With support from the Dutch Ministry of Health, the Netherlands participates in the SOP for Medication Accuracy at Transitions in Care. After successful implementation of this SOP for individuals aged 65 and older admitted through the ED, the SOP will be expanded to all individuals at admission (acute and nonacute), internal transfers, and discharge. The (inter) national goal of the WHO High 5s SOP implementation is to achieve a 75% reduction in medication discrepancies in the target population. The results of the Dutch WHO High 5s study program are reported in this article. The main aim of this Dutch study was to determine the effect of pharmacy-based medication reconciliation (in accordance with the SOP and aiming to show a 75% reduction as the goal of the High 5s project) on the frequency of medication discrepancies in participating hospitals in acutely admitted individuals aged 65 and older. Secondary aims were to determine the effect on medication discrepancy types and the percentage of unintentional medication discrepancies at several time points after implementation of the intervention.

METHODS

Study Design and Setting

An observational multicenter study with a pre–post design was set up. Twelve hospitals from all regions of the Netherlands participated. Two of the hospitals were university medical centers (Radboud University Nijmegen Medical Centre and VU University Medical Centre Amsterdam), three were large teaching hospitals (Medical Centre Alkmaar, St Francis Gasthuis Rotterdam, and HAGA Teaching Hospital The Hague), and the other seven were general hospitals (Rivas Beatrix Hospital Gorinchem, Franciscus Hospital Roosendaal, Rivierenland Hospital Tiel, Tergooi Hospitals Hilversum/Blaricum, Diakonessenhuis Utrecht/Zeist/Doorn, Ziekenhuisgroep Twente (ZGT) Almelo/Hengelo, and Antonius Hospital Sneek).

Medical ethical approval was not necessary according to Dutch trial law, but the VU University Medical Centre medical ethics committee provided a waiver for the study.

Participants

Individuals aged 65 and older with an acute hospital admission through the ED were included in the study. Individuals without medication were excluded.

Study Period

The Dutch WHO High 5s program on medication reconciliation started on January 28, 2010, but the data collection period (actual study period) lasted from March 2010–July 2012 (depending on the hospital).

Usual Care

During usual care, nurses and physicians were responsible for medication history taking in the EDs or the departments to which the individual is transferred. In general, they used patient information (from a nonstructured interview), general practitioner information, and medication containers to perform medication reconciliation. Community pharmacy records were rarely used as a source of information. Within the High 5s program, a preintervention measurement period of 1 month was chosen, with a minimum inclusion of 30 participants per hospital.

Intervention

The intervention (SOP) consisted of the introduction of the Best Possible Medication History (BPMH), which was defined as the list of medicines on admission, which is based on combining the information from the community pharmacy record, the information provided by a structured interview with the participant about medication use, and medication containers. The structured interview consisted of the following items:

- Introduction: short introduction by pharmacy technician on the aim of the interview.
- Medication allergies: any medication allergies and the symptoms associated with them.
• Information gathering: asking for the medication containers, discussing how all medication is taken (dose, route, frequency, time), asking for recently stopped or changed prescription medication and the reason for this.
• Over-the-counter (OTC) medication: asking whether the participant used any OTC medication, including vitamins, minerals, and supplements.
• Special dosage forms: asking for dosage forms that can easily be forgotten or deleted from the community pharmacy record (e.g., multidose vials; eye, ear, or nose drops; inhalers; patches; creams; ointments).
• Other: asking whether the participant used trial medication or medication with special dosing frequencies (e.g., methotrexate for rheumatoid arthritis).
• Closing: thanking the participant and asking for questions.

If the participant was unable to participate in the interview, the family of the participant was interviewed. The information from the interview was compared with information from the medication containers and from the community pharmacy records, and discrepancies were resolved, resulting in a final list of medications. This final list was based on the medications that participants reported taking, unless any medications were considered erroneous or caused a risk to the participant, in which case these items were discussed with the treating physician. For all participants, the BPMH was required to be obtained as soon as possible, preferably within 24 hours after hospital admission. In all hospitals, pharmacy technicians obtained the BPMH after receiving training and under the supervision of a hospital pharmacist, although in three hospitals, a mixed model was used (physicians or pharmacy technicians obtained the BPMH, depending on the department the participant was sent to after the ED). In the Netherlands, a pharmacy technician is not a licensed pharmacist but a professional trained in medication preparation, medication dispensing, patient education, and medication reconciliation. Pharmacy technicians always perform their activities under the supervision of licensed pharmacists. This supervision consists of in-process checks and protocols to ensure safe medication handling and medication reconciliation.

In hospitals using the mixed model, physicians received training in obtaining the BPMH (comparable to the training pharmacy technicians received) or were provided with materials supporting obtaining the BPMH (e.g., format for structured interview).

The postintervention measurement period started after implementation of the intervention, which lasted 2–4 months. Measurements continued until July 2012, so no predetermined number of participants was set for the postintervention measurement phase. Several measurement periods were conducted after the intervention, for up to six periods per hospital, with each measurement period being 1 month apart from the previous.

Measurement of Medication Discrepancies
In both measurement periods, an independent observer checked the medication history on admission for any medication discrepancies. The independent observer was a person who was familiar with the medication reconciliation process and how to obtain a BPMH. It could be a clinician (nurse, pharmacist, physician) or quality staff member. For the present study, independent observers were pharmacists or pharmacy technicians (other than those performing the intervention). The process by the independent observer consisted of comparing the BPMH (made during routine care in the preintervention measurement phase; according to the SOP in the postintervention measurement phase) with all sources of information on medication use before admission. This included information from the participant as written down after the participant interview (unstructured in routine care; structured according to SOP in postintervention phase).

Definitions and Classification
A medication discrepancy was defined as a difference between the medicines ordered on admission (in the postintervention measurement phase based on the BPMH as described in the SOP and in the preintervention measurement phase based on regular care by the nurses and physicians) and the information that the independent observer gathered. An unintentional medication discrepancy was defined as a medication discrepancy that the physician did not intend (no reason recorded or no potential reason clarified after checking with the prescribing physician). Medication discrepancies were further classified according to the classification in Table 1.

Data Collection
Information on general participant characteristics (age; sex; hospital; number of medicines on admission, including added and omitted medication; and department transferred from to the ED), medication characteristics (name, Anatomic Therapeutic Chemical (ATC) code14), and medication discrepancies was collected.

Outcome Measures
Primary outcome measures were the proportion of participants with one or more unintentional medication

<table>
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<tr>
<th>Table 1. Classification of Medication Discrepancies</th>
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<td>Type</td>
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<tr>
<td>Omission</td>
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<tr>
<td>Medicine added</td>
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<td>Dosage or strength</td>
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discrepancies and the proportion of medication orders with one or more unintentional medication discrepancies. The primary outcome measures were stratified according to type of intervention [pharmacy based (9 hospitals) vs mixed model (three hospitals)].

Secondary outcome measure was type of medication discrepancies and percentage of unintentional medication discrepancies over time (after implementation).

Data Analysis

Participant data were collected in MS Access 97 databases (Microsoft, Redmond, WA) in each hospital. For each hospital, these data were transferred to SPSS Statistics version 20 (IBM Corp., Armonk, NY), and the data were merged for all hospitals.

Participant and medication characteristics were compared for pre- and postintervention measurement groups using the two-sample t-test (normal distribution) or Mann-Whitney U-test (nonparametric) for continuous variables and chi-square test for dichotomous variables.

Primary outcome measures were analyzed using univariate logistic regression analysis. The analysis of the primary endpoints was adjusted using multivariate logistic regression analysis for any variables for which there was a statistically significant difference (P < .05) between the measurement periods. Hospital was always included in the multivariate logistic model to adjust for organizational differences that specific data collected did not account for.

Only descriptive statistics were used for the secondary outcome measure.

RESULTS

One thousand five hundred forty-three participants were included (350 in the three mixed-model hospitals): 436 in the preintervention measurement phase (81 in the mixed-model hospitals) and 1,107 in the postintervention measurement phase (269 in the mixed-model hospitals). In the preintervention measurement phase, 3,618 medication orders were collected (800 in the mixed model hospitals) and 9,277 in the postintervention measurement phase (2,572 in the mixed model hospitals). In both measurement periods, medication acting on the nervous system (ATC class N), gastrointestinal medication (ATC class A), cardiological medication (ATC class C), medication acting on the blood (ATC class B), and respiratory medication (ATC class R) were the most frequently used classes of medication.

Fifty-seven to 236 participants were included per hospital. Table 2 shows the general characteristics of the study population and the prescribed medication. Age, sex,
and number and type of medicines did not differ between the measurement periods. There was a significant difference in the type of department participants were transferred to, so department type was included in the multivariate analysis, as was the hospital.

The proportion of participants with one or more unintentional medication discrepancies fell from 62% (268/436 participants) before the intervention to 32% (350/1,107 participants) (odds ratio (OR) = 0.29, 95% confidence interval (CI) = 0.23–0.37) after the intervention. After adjustment for type of department and hospital, these results remained statistically significant (OR = 0.20, 95% CI = 0.15–0.26) (Table 3).

The proportion of medication orders with one or more unintentional medication discrepancies fell from 18% (643/3,618 orders) to 8% (743/9,277 orders) (OR = 0.40, 95% CI = 0.36–0.45). Again, this remained statistically significant after adjustment for potential confounders (OR = 0.30, 95% CI 0.27–0.35).

The goal of the WHO High 5s project—a 75% reduction in medication discrepancies—was achieved only in the pharmacy-based model and using medication orders as the unit of analysis (79% reduction). When using participants with one or more medication discrepancies as the unit of analysis, a 65% reduction was achieved in the pharmacy-based model (Table 3). Stratified analysis showed that no effect from the intervention was evident in the three hospitals with a mixed-model intervention, in contrast to the hospitals with a pharmacy-based intervention (Table 3).

Table 4 shows the types of unintentional medication discrepancies identified in the pre- and postintervention measurement phases. The intervention mainly influenced the discrepancies of omission and dosage or strength, which were also the most frequently occurring types. Because the effect of interventions may decrease as time passes, the measurement number (a difference in number of 1 represents 1 month) was also plotted against the percentage of unintentional medication discrepancies (Figure 1). As Figure 1 shows, the effect remained relatively stable during the consecutive measurement periods (although not all hospitals participated in all measurements).

**DISCUSSION**

This multicenter study of the effect of pharmacy-based medication reconciliation in acutely admitted elderly adults has shown that this intervention results in substantial improvement in the proportion of medication discrepancies.

Previous studies have shown that one or more medication discrepancies occur in EDs in 37–87% of individuals. The current study found a proportion (62%) in the preintervention measurement phase that lies within this range. The reduction in medication discrepancies was substantial but smaller than in a previous Dutch study of medication reconciliation of planned admissions by pharmacy technicians. The fact that a BPMH is more difficult to obtain in acutely admitted individuals (e.g., because they are generally more ill than planned admissions and therefore cannot be interviewed on their medication use) or that not all hospitals had pharmacy technicians obtain BPMHs may explain this. Three hospitals used a mixed model in which physicians performed medication history taking. Because the adjustment for hospital and ward type resulted in a substantial reduction in the odds ratio, this effect may be important. The stratified analysis (these three hospitals vs the other hospitals) confirms this; only pharmacy-based medication reconciliation results in a significant reduction of medication discrepancies. A recent study also supports

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**Table 3. Proportion of Participants and Medication Orders with One or More Unintentional Medication Discrepancies for Pre- and Postintervention Measurement Group**

| Outcome | Preintervention (n = 436 Participants, n = 3,618 Medication Orders) | Postintervention (n = 1,107 Participants, n = 9,277 Medication Orders) | Crude Odds Ratio | Adjusted *
|---------|-------------------------------------------------|-------------------------------------------------|-----------------|--------
| Participants with ≥1 medication discrepancies | | | | 0.29 (0.23–0.37) | 0.20 (0.15–0.26)
| All hospitals | 268 (62) | 350 (32) | | 1.45 (0.88–2.39) | 1.18 (0.68–2.06)
| Pharmacy based | 225 (63) | 183 (22) | | 1.45 (0.88–2.39) | 1.18 (0.68–2.06)
| Mixed model | 43 (53) | 167 (62) | | 1.45 (0.88–2.39) | 1.18 (0.68–2.06)
| Medication orders with ≥1 discrepancies | | | | 0.40 (0.36–0.45) | 0.30 (0.27–0.35)
| All hospitals | 643 (18) | 743 (8) | | 0.18 (0.15–0.21) | 0.18 (0.15–0.21)
| Pharmacy based | 548 (19) | 278 (4) | | 0.18 (0.15–0.21) | 0.18 (0.15–0.21)
| Mixed model | 95 (12) | 465 (18) | | 1.64 (1.29–2.08) | 1.09 (0.63–1.44)

* Adjusted for type of department transferred to after emergency department and for hospital.
Discrepancies were identified in 92% of participants. This is probably a reflection of the fact that pharmacy personnel can dedicate more time and effort to this process than physicians and nurses generally can, as a pharmacy-based intervention, the WHO High 5s goal of at least a 75% reduction in medication discrepancies was achieved (with medication orders as the unit of analysis).

The postintervention proportion of medication discrepancies remained high, indicating that there is room for additional improvement. This improvement may be achieved by carefully comparing the implementation at the best-performing hospital with that at the other hospitals. The performance of medication reconciliation by pharmacy technicians instead of physicians may then be one of the measures improving results.

The intervention reduced the subtypes of medication discrepancies of omission and dosage or strength, whereas the subtype of added medication remained unchanged.

To the knowledge of the authors, this is the first multicenter study of the effect of pharmacy-based medication reconciliation in acutely admitted elderly adults. It was performed in different types of hospitals from regions throughout the Netherlands and can thus be considered generalizable. Furthermore, several measurement periods were included after implementation, which enabled the sustainability of the intervention during the 6-month postintervention phase (which is still short) to be shown. Notwithstanding these strengths, certain limitations need to be discussed.

The introduction of the BPMH reduced the proportion of individuals with one or more unintentional medication discrepancies from 62% (268/436 participants) to 32% (350/1,107 participants) (adjusted OR = 0.20, 95% CI = 0.15–0.26). Stratified analysis showed that no effect of the intervention was evident in the three hospitals with a mixed-model intervention, in contrast to the hospitals with a pharmacy-based intervention. In hospitals with a pharmacy-based intervention, the WHO High 5s goal of at least a 75% reduction in medication discrepancies was achieved (with medication orders as the unit of analysis).

The intervention mainly influenced the discrepancies of omission and dosage or strength, which were also the most frequently occurring types. The effect remained relatively stable after 6 months.

CONCLUSION

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Author Contributions: Van den Bent and Van der Schriek-de Loos had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Van den Bent, Van der Schriek-de Loos, Van der Linden, Theeuwes, Pol. Acquisition of data: CBO High 5 Study Group members, Van den Bent, Van der Schriek-de Loos. Analysis and interpretation of data: Van den Bent, Van der Schriek-de Loos, Van der Linden, Theeuwes, Pol. CBO. Drafting of the manuscript: Van den Bent. Critical revision of the manuscript for important intellectual content: Van der Schriek-de Loos, Van der Linden, Theeuwes, Pol, CBO High 5 Study Group members. Statistical analysis: Van den Bent. Obtaining funding: Van der Schriek-de Loos. Administrative, technical, and material support: Van den Bent, Van der Schriek-de Loos, Van der Linden, Theeuwes, Pol. Study supervision: Van den Bent, Van der Schriek-de Loos, Van der Linden, Theeuwes, Pol.

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REFERENCES


APPENDIX

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