

Original Research

Frequency of occurrence of medication discrepancies and associated risk factors in cases of acute hospital admission

Charlotte D. VAN DER LUIT, Iris R. DE JONG, Marieke M. EBBENS^{id}, Sjoerd EUSER^{id},
Sjoerd L. VERWEIJ^{id}, Patricia M. VAN DEN BEMT^{id}, Hanneke M. LUTTIKHUIS^{id}, Matthijs L. BECKER^{id}.

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Abstract

Background: Medication discrepancies are a common occurrence following hospital admission and carry the potential for causing harm. However, little is known about the potential risk factors involved in medication discrepancies.

Objective: The objective of this study was to determine how frequently medication discrepancies occur and their associated risk factors, in patients hospitalized via the emergency department of the Spaarne Gasthuis Hospital, located in The Netherlands.

Methods: This retrospective observational study examines 832 hospital admissions which took place between April 1st and June 30th, 2015. Medication reconciliation was performed within 24 hours of admission and medication discrepancies were registered. The primary outcome recorded in the study was the proportion of patients experiencing one or more medication discrepancies, as verified by the physician. As a secondary outcome, the association between these discrepancies and pre-specified variables was analyzed using univariate and multivariate logistic regression.

Results: At least one medication discrepancy was found to have occurred with 97 of the 832 patients (11.7%), the most common discrepancies involving incorrect drug dose (44.9%) and omission of medication (36.4%). In the univariate analysis, age (OR=1.03 [95% CI 1.02:1.04] $p<0.001$) and number of pre-admission medications taken (OR=1.13 [95% CI 1.09:1.17] $p<0.001$) were revealed to be significantly associated with the risk of medication discrepancies. Sex, type of medical specialty, and surgical versus non-surgical specialty were found not to be significantly associated with discrepancies. In the multivariate analysis, both the number of pre-admission medications (OR=1.10 [95% CI 1.06:1.15] $p<0.001$) and age (OR=1.02 [95% CI 1.01:1.03] $p=0.004$) were independently associated with the risk of medication discrepancy.

Conclusions: Of the total number of patients, 11.7% experienced one or more medication discrepancies following admission to the hospital. Elderly patients taking multiple drugs were found to be particularly at risk.

Keywords

Medication Reconciliation; Medication Errors; Documentation; Hospitalization; Patient Admission; Multivariate Analysis; Retrospective Studies; Netherlands

INTRODUCTION

Up to two-thirds of all hospitalized patients will experience one or more discrepancies (differences) between the

patient's medication history as determined at the point of hospital admission, and the medication prescribed during hospitalization.¹ Medication discrepancies occur most frequently at the point of hospital admission and discharge.^{2,3} Between 11 and 59% of medication discrepancies are potentially harmful.¹ This constitutes a major public health burden, and one which is largely preventable.^{2,4}

In the hospital setting, it is often not feasible for pharmacy professionals to perform medication reconciliation for all patients at the point of admission and discharge. To optimize quality of healthcare, it is important to identify the patient group most likely to incur medication discrepancies. Medication reconciliation for patient groups at particular risk should ideally be performed by pharmacy professionals.⁵⁻⁷ In the Netherlands, this task is most often performed by pharmacy technicians who work under the supervision and responsibility of a pharmacist. The review by Hias *et al.* examined the risk factors for medication discrepancy and identified a correlation between patient characteristics and medication discrepancies at the point of admission.⁸ However, the studies reviewed mostly involved a small number of patients. These researchers also showed that the potential risk factors identified varied between different studies.⁸ The number of pre-admission drugs

Charlotte D.E. VAN DER LUIT*, Pharmacy Technician. Pharmacy Foundation of Haarlem Hospitals. Haarlem (Netherlands). cluit@sahz.nl

Iris R. DE JONG*, Pharmacy Foundation of Haarlem Hospitals. Haarlem; & University of Groningen, Faculty of Science and Engineering. Groningen (Netherlands). irisriannedejong2@gmail.com

Marieke M. EBBENS, PharmD. Clinical Pharmacist, Researcher. Department of Pharmacy, St Jansdal Hospital. Harderwijk; & Department of Hospital Pharmacy, Erasmus University Medical Centre. Rotterdam (Netherlands). M.M.Ebbens@lumc.nl

Sjoerd EUSER, PhD. Researcher. Spaarne Gasthuis Academy, Spaarne Gasthuis. Haarlem (Netherlands). S.Euser@streeklabhaarlem.nl

Sjoerd L. VERWEIJ, PharmD. Clinical Pharmacist. Pharmacy Foundation of Haarlem Hospitals. Haarlem (Netherlands). sverweij@sahz.nl

Patricia M.L.A. VAN DEN BEMT, PharmD, PhD. Clinical Pharmacist, Professor in Medication Safety. Department of Hospital Pharmacy, Erasmus University Medical Centre. Rotterdam (Netherlands). p.vandenbemt@erasmusmc.nl

Hanneke M. LUTTIKHUIS, PharmD. Clinical Pharmacist. Pharmacy Foundation of Haarlem Hospitals. Haarlem (The Netherlands). hlutikhuis@sahz.nl

Matthijs L. BECKER, PharmD, PhD. Clinical Pharmacist, Researcher. Pharmacy Foundation of Haarlem Hospitals. Haarlem (Netherlands). mbecker@sahz.nl

* These authors contributed equally

taken was the most frequently identified risk factor for discrepancies in general, whereas age was the most frequently identified risk factor for potentially harmful discrepancies.⁸ Other risk factors, such as gender, type of care before admission, number of comorbidities and type of care received prior to admission, were all associated with medication discrepancies - significantly in some studies, and non-significantly in others.⁸

Contradictory results imply that the potential risk factors for the occurrence of medication discrepancies are still not fully elucidated. Since no conclusive outcome can be found in the literature, more research is needed to identify the risk factors in this area. The aim of this study, therefore, is to determine the frequency with which medication discrepancies occur, and the associated risk factors in patients hospitalized through the emergency department of the Spaarne Gasthuis Hospital in The Netherlands. This admission group was selected, because the urgency of the patients' situation lends itself to greater risks regarding this issue.

METHODS

Study design and population

For this retrospective observational study, data were obtained from the Spaarne Gasthuis Hospital located in Haarlem, The Netherlands. Patients were included in the study if they visited the emergency department and were subsequently admitted to the hospital between April 1st and June 30th, 2015. A further inclusion criterion was the performing of medication reconciliation by the pharmacy technician, following the treating physician entering the prescribed medication on the hospital information system Epic (Verona, WI, USA). Medication reconciliation was performed within 24 hours of admission. Available sources were reviewed in order to obtain the best possible medication history. The available medication history, as stored in the hospital information system, in cases where the patient had been previously hospitalized. The availability of medication records from the community pharmacy was also checked; in The Netherlands, medication dispensed by pharmacies is registered electronically, and this information is accessible to other healthcare professionals if the patient has granted permission for this. With these lists of medication as the starting point, semi-structured interviews with each of the patients and/or caregivers were performed, and for each drug the drug name, dosage, frequency, and route were checked. If discrepancies were identified, these were communicated to the treating physician. For patients who were re-hospitalized in the study period, only the first hospitalization was included. Patients who used no medication before admission were excluded from the study.

This study is a retrospective observational study, and as such does not need the approval by a Medical Ethics Committee, according to the Dutch Medical Research Involving Human Subjects Act. All patients received usual care and data were gathered retrospectively and processed anonymously, according to privacy legislation.

Data collection and monitoring

The data were collected from the hospital information system using SAP Crystal Reports (Walldorf, Germany). The extracted data were converted to Microsoft Excel version 2010 (Redmond, WA, USA). For every admission, medications prescribed prior to admission, medications prescribed on hospital admission, age, sex, and the medical specialty treating the patient, were extracted. Medications were classified according to the World Health Organization (WHO) Anatomical Therapeutic Chemical (ATC) methodology.⁹ The integrity of the data was sample-wise checked by a clinical pharmacist.

Outcome measures

The primary outcome assessed by the study was the proportion of patients experiencing one or more medication discrepancies. Medication discrepancy is defined as an inconsistency between the actual medication as detailed in Epic and the best possible medication history based on the medication reconciliation. Any inconsistency was discussed with the attending physician. Cases where the physician did not accept the proposal of the pharmacy technician and therefore did not change the prescribed medication were not included as a medication discrepancy, as the physician may have changed or stopped the medication intentionally. Four types of discrepancy were distinguished in this study: omission of medication, differing drug dose (including differing frequency of administration), restarting stopped medication, and incorrect drug (including different drug routes).

The following potential risk factors were assessed: age, sex, type of medical specialty, surgical specialty versus non-surgical, and number of drugs taken prior to admission. The secondary outcome assessed by the study was the type of medication involved in the medication discrepancy classified using the first level (anatomical main group) of the WHO ATC group, as well as the frequency of medication discrepancies as cited by this group.⁹

Data Analysis

IBM SPSS Statistics for Windows version 24 (IBM Corp, Armonk, NY) was used for the statistical analyses. Descriptive analysis was used to analyze the frequency of medication discrepancies. Univariate binary logistic regression was conducted to determine which pre-specified variables were significantly associated with the occurrence of medication discrepancies. All potential predictors with a p-value <0.05 were entered into the multivariate logistic regression analysis, adjusting for potential confounders. A p value below 0.05 was regarded as statistically significant and 95% confidence intervals are reported.

RESULTS

During the study period, a total of 999 medication reconciliations were performed, all occurring within 24 hours of hospital admission. Sixty-three medication reconciliation interviews were excluded on account of the patients being re-hospitalized within the study period. A further 104 patients were excluded because they did not

Sex,	n (%)
Male	387 (46.5)
Age in years, mean (SD) ^a	63.5 (23.5)
Age categories,	n (%)
≤18	60 (7.2)
19-45	94 (11.3)
46-65	198 (23.8)
66-75	157 (18.9)
76-85	204 (24.5)
>85	119 (14.3)
Medical specialty	no (%)
Gastroenterology	88 (10.6)
Geriatrics	116 (13.9)
Internal	203 (24.4)
Neurology	63 (7.6)
Pediatrics	45 (5.4)
Pulmonology	101 (12.1)
Surgical	187 (22.5)
Other ^b	29 (3.5)
Num. medications prior to admission, mean (SD)	6.9 (4.9)
minimum	1
maximum	26
^a SD = standard deviation	
^b Others; includes urology, gynecology, dental specialisms, cardiology, otorhinolaryngology	

use medication before admission. Thus, 832 patients were included in the analyses (Table 1).

In 97 of the 832 patients, at least one medication discrepancy was detected (11.7%). A total of 176 medication discrepancies were identified in these 97 patients, which gives a frequency of 0.21 discrepancies per admission and 1.8 discrepancies per admission with at least one medication discrepancy. The prescribing of an incorrect drug dose was found to be the most common discrepancy type, followed by the omission of medication (Table 2). Drugs most frequently involved in medication discrepancies pertained to the ATC groups 'Systemic hormonal preparations', 'Cardiovascular system' and 'Sensory organs' (Table 3).

The univariate logistic regression analysis showed that age (OR=1.03 [95%CI 1.02:1.04] p<0.001) was significantly associated with the risk of medication discrepancy (table 4). Patients younger than 18 years had the lowest risk and the risk increased in patients of 66 years and above. Furthermore, a significant association between the number

Type of discrepancy	N (%)
Omission of medication	64 (36.4)
Differing drug dose	79 (44.9)
Restarting stopped medication	14 (8.0)
Incorrect drug	19 (10.8)

of medications taken prior to admission (OR=1.13 [95%CI 1.09:1.17] p<0.001) and the risk of medication discrepancies, was found. In patients using less than seven medications, the frequency of one or more medication discrepancies at admission was 0.05, while in patients using seven or more medications the frequency was 0.24. No significant association was found with sex and medical specialty. In the multivariate analysis, the number of pre-admission medications taken (OR=1.10 [95%CI 1.06:1.15] p<0.001) and age (OR=1.02 [95%CI 1.01:1.03] p=0.004) were statistically significantly associated with the frequency of medication discrepancy.

DISCUSSION

In approximately one in nine acutely admitted patients at least one medication discrepancy was identified during medication reconciliation. Independent risk factors for medication discrepancy were identified as age and the number of pre-admission medications taken. The prescribing of an incorrect drug dose was the most common discrepancy, followed by the omission of medication. In our study, medication discrepancies were excluded if the physician did not change the discrepancy following notification.

A study by Allende Bandrés *et al.* differentiated medication discrepancy justified by a pharmacist and found a frequency of 1.8 medication discrepancies per admission with at least one medication discrepancy, which is in line with the current study's findings.¹⁰ Cornu *et al.* identified 279 medication discrepancies which were accepted in 163 patients (giving a frequency of 1.7, as compared to 1.8 in the current study).¹¹ The study also revealed a frequency of 1.4 medication discrepancies per admission, which is higher than the current study's findings, of a frequency of 0.21. However, there are substantial differences in methodology between the current study and that of Cornu *et al.* – for example, in the latter study, only patients aged 65 years and older were included. The average age in the study

ATC-code	Number of prescribed medications	Number of discrepancies (n=176)	Discrepancies per ATC-group (%)
A: Alimentary tract and metabolism	1373	45	3.3
B: Blood and blood forming organs	532	4	0.8
C: Cardiovascular system	1284	51	4.0
D: Dermatologicals	130	5	3.8
G: Genito-urinary system and sex hormones	109	4	3.7
H: Systemic hormonal preparations ^a	170	9	5.3
J: Anti-infective for systemic use	130	1	0.8
L: Antineoplastic and immunomodulating agents	55	0	0.0
M: Musculo-skeletal system	210	4	1.9
N: Nervous system	944	25	2.6
R: Respiratory system	534	17	3.2
S: Sensory organs	110	10	9.1
Others	44	1	2.3
^a excluding sex hormones and insulin's			

Table 4. Univariate and multivariate analyses: possible risk factors for medication discrepancies.

Variable	All admissions (n=832)	Discrepancies/admission (n=97) (%) ^a	Odds ratio [95%CI]	Adjusted Odds ratio [95%CI]
Sex				-
Female	445	51 (11.5)	1 (ref)	
Male	387	46 (11.9)	1.04 [0.68:1.59]	
Age, years (SD)	63.5 (23.5)	74.0 (14.3)	1.03 [1.02:1.04] *	1.02 [1.01:1.03] *
Age categories, in years				-
≤18	60	1 (1.7)	0.51 [0.05:5.06]	
19-45	94	3 (3.2)	1 (ref)	
46-65	198	13 (6.6)	2.13 [0.59:7.67]	
66-75	157	29 (18.5)	6.87 [2.03:23.25] *	
76-85	204	34 (16.7)	6.07 [1.81:20.30] *	
>86	119	17 (14.3)	5.06 [1.44:17.81] *	
Number of medications taken prior to admission (SD)	6.9 (4.9)	9.9 (4.1)	1.13 [1.09:1.17] *	1.10 [1.06:1.15] *
Type of medical specialty, no				-
Non-surgical	620	74 (11.9)	1 (ref)	
Surgical	212	23 (10.8)	0.90 [0.55:1.48]	
Medical specialty				-
Gastroenterology	88	8 (9.1)	0.56 [0.24:1.26]	
Geriatrics	116	16 (13.8)	0.89 [0.46:1.70]	
Internal	203	31 (15.3)	1 (ref)	
Neurology	63	5 (7.9)	0.48 [0.18:1.29]	
Pediatrics	45	1 (2.2)	0.13 [0.02:0.95] *	
Pulmonology	101	12 (11.9)	0.75 [0.37:1.53]	
Surgical	187	22 (11.8)	0.74 [0.41:1.33]	
Other ^b	29	2 (6.9)	0.41 [0.09:1.82]	

^a percentage of the number of admissions; ^b 'Other' includes urology, gynecology, dental specialisms, cardiology, otorhinolaryngology.
* statistically significant at p<0.05

population assessed by Cornu *et al.* was therefore older than in the current study (83.7 versus 63.5 years) and the study population used more medications prior to admission (7.2 versus 6.9). Since the current study found an association between increasing age and higher numbers of pre-admission medications, and the occurrence of medication discrepancies, it can be assumed that those particular risk factors contributed to the relatively high frequency of discrepancies reported by Cornu *et al.*

To the best of the author's knowledge, this is the first study to assess the frequency of occurrence of medication discrepancies according to WHO ATC group. Patients using medications from the ATC groups 'Systemic hormonal preparations', 'Cardiovascular system' and 'Sensory organs' were found to be at greater risk. Four previous studies have divided up medication discrepancies according to drug class.⁸ The most common discrepancy that was found in the current study was incorrect drug dose. This is not consistent with earlier studies, in which omissions constituted the most common discrepancy found.¹ This difference in findings may be explained by differences in methodology. Omitting to prescribe a drug might be intentional, while in the current study only medication discrepancies that were accepted by the physician were included.

The number of pre-admission medications taken was the most frequently identified risk factor for medication discrepancy in the review conducted by Hias *et al.*⁸ The odds ratio for each additional medication varied from 1.09 to 1.47 in these studies, compared with 1.13 in the current study.⁸ Age was also investigated as a risk factor, but the literature revealed no conclusive outcome.⁸ Studies inferred that increasing age is associated with the frequency of medication discrepancy did not always adjust

for potential confounders such as underlying diseases.^{1,2,10,11} The results detailed are similar to those of the current study. Hias *et al.* showed that 5 out of 24 studies found an association between sex and the frequency of medication discrepancies.⁸ Our results showed no association between sex and the number of medication discrepancy, in line with other studies.⁸

Our study has both strengths and limitations. Firstly, this study is noteworthy in that, to the best of our knowledge, it is the largest study to date examining the risk factors for medication discrepancy in acutely admitted patients. Secondly, this study excluded discrepancies that were not accepted by the physician following notification. Thirdly, this study analyzed the medication discrepancies with reference to ATC grouping in order to assess whether some medications were more often involved in discrepancies than others. A potential limitation of the study is that we did not include medication discrepancies that remained unchanged by the physician after notification. It was assumed that, in such cases, the discrepancies were intentional rather than being in error. It is possible that this resulted in a lower frequency of medication discrepancies in our study, compared to earlier studies. Secondly, this study did not differentiate between discrepancies that were not clinically relevant and those that were. Thirdly, this study was performed in just one hospital, potentially limiting the generalizability of the results.

This study suggests the importance of performing medication reconciliation. It confirms that patient age and the number of preadmission medications taken are independent risk factors for medication discrepancy in acutely admitted patients and identifies various drug groups as being particularly susceptible. It is recommended that medication reconciliation to be conducted prior to

prescription, to mitigate the possibility of medication errors. Future research might examine how to better differentiate between accepted and not accepted medication discrepancies and determine the clinical relevance of this issue.

CONCLUSIONS

To conclude, approximately one in nine patients acutely admitted to the hospital were found to have experienced one or more medication discrepancies. Patients using medications from the ATC groups 'Systemic hormonal preparations', 'Cardiovascular system' and 'Sensory organs' were most at risk in this regard. Both increasing age and a higher number of pre-admission medications were found to

be potential risk factors for medication discrepancies during admission. It is suggested that consideration should be given to deploying pharmacy professionals in the performing of the medication reconciliation for these high-risk patients, in order to reduce the occurrence of medication discrepancy following hospital admission.

CONFLICT OF INTEREST

None of the authors have any conflict of interest to declare.

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