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

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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. Medication discrepancies occur most frequently at the point of hospital admission and discharge. Between 11 and 59% of medication discrepancies are potentially harmful. This constitutes a major public health burden, and one which is largely preventable. 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. 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. 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. The number of pre-admission drugs
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. 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 nonsurgical, 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.

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...
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 discrepancies 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. 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). 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 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**

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 were included in 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

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**Table 1. Baseline characteristics (n = 832)**

| Sex             | n (%)  |
|-----------------|--------|
| Male            | 387 (46.5) |
| Age in years, mean (SD) | 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) |

**Table 2. Type of medication discrepancy (n=176)**

| 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) |

**Table 3. Number of prescribed medications and discrepancies per ATC group.**

| 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 | 170 | 9 | 5.3 |
| I: 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 |

* excluding sex hormones and insulin’s
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. 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.

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. 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. Age was also investigated as a risk factor, but the literature revealed no conclusive outcome. Studies inferred that increasing age is associated with the frequency of medication discrepancy did not always adjust for potential confounders such as underlying diseases. 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. Our results showed no association between sex and the number of medication discrepancy, in line with other studies.

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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