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SHORT RESEARCH REPORT

# Drug-related problems in patients with ischemic stroke in hospital

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**Abstract** *Background* Drug therapy is getting more complex, thus making it more challenging to prescribe appropriate drug therapy. Accordingly, in clinical practice, a wide range of drug-related problems (DRP) may arise; they are relatively common in hospitalised patients and can result in patient morbidity and mortality, and increased costs. *Objective* The objective was to investigate the nature and frequency of DRPs along with pharmaceutical interventions to address them in patients with ischemic stroke from hospital admission to discharge. *Method* From January to June 2011 patients with ischemic stroke, who were taking >2 drugs during hospital stay and at discharge, were recruited. A clinical pharmacist performed medication reconciliation on admission, and checked the medication records during the hospital stay regularly. DRPs were categorized by APS-Doc. *Results* In total, DRPs occurred in 105/155 (67.7 %) patients: Overall 271 DRPs were documented, with a mean of 1.8 ± 2.0 DRPs per patient. The DRPs occurred mainly in the categories "drug", "indication", and "dosage". *Conclusion* In conclusion, DRPs are relatively common in hospitalised patients and may occur at any part of the prescribing process. The clinical pharmacist can provide a valuable contribution in the multidisciplinary team to an optimized pharmacotherapy in patients with ischemic stroke.

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**Keywords** APS-Doc · Drug-related problems · Germany · Hospital setting · Ischemic stroke · Pharmaceutical intervention

**Abbreviations**

| | |
|---|---|
| DRP | Drug-related problem |
| IQR | Interquartile range |
| MDRD | Modification of Diet in Renal Disease |
| n/a | Not available |
| SD | Standard deviation |
| TIA | Transient ischemic attack |

## Impacts on practice

- Clinical pharmacists can identify and resolve DRPs in patients with ischemic stroke
- In patients with ischemid stroke we found stroke-related DRPs which referred mainly to antihypertensive medication, secondary prevention, and statin therapy.

## Introduction

Drug therapy is getting more complex, thus making it more challenging for physicians to prescribe appropriate drug therapy. Accordingly, in clinical practice, a wide range of drug-related problems (DRP) may arise; they are common in hospitalised patients and can result in patient morbidity and mortality, and increased costs [1]. Identifying, preventing, and resolving DRPs is an important issue in the pharmaceutical care process [2]. DRP, defined as an event or circumstance that actually or potentially interferes with

desired health outcomes, can lead to ineffective pharmacotherapy, and may cause drug-related morbidity and mortality [3]. Medication review is an evaluation of prescribed medicines with the aim of managing the risk and optimizing the outcome of drug therapy by detecting, resolving and preventing DRPs; these can occur at any time during the medication process, at hospital admission, during hospital stay, and at hospital discharge.

Although published data are limited, the available information suggests that medication errors are common among patients hospitalized for acute ischemic stroke. A retrospective evaluation of 234 stroke cases revealed a 19 % in hospital incidence rate of medication errors [4].

## Aim of the study

The aim was to investigate the nature and frequency of DRPs along with pharmaceutical interventions to address them in patients with TIA (transient ischemic attack) or ischemic stroke from hospital admission to hospital discharge.

## Method

### Study design

A prospective study was conducted at the Klinikum Fulda gAG from January to June 2011. Patients with TIA or ischemic stroke, at least 18 years of age, who were taking 2 or more drugs during hospital stay and at discharge, were recruited.

An experienced clinical pharmacist performed medication reconciliation of each patient on hospital admission, checked the medication records during the hospital stay regularly, and took part on ward rounds.

The following parameters were recorded: age, gender, renal function, allergies, main diagnosis, cardiovascular risk factors, drugs prescribed prior to admission, and the current medication. DRPs were detected and documented along with pharmaceutical interventions, defined as any recommendation made with the intent of changing drug treatment. For each DRP it was determined whether it was already present on admission or occurred during the hospital visit or at discharge. Furthermore, it was recorded whether the pharmaceutical intervention was followed or not, the extent to which the DRP was resolved, whether no action was necessary along with whether the prescribing physician, nurse, and/or patient or their caregivers were involved in resolving the DRP. All DRPs were categorized using APS-Doc [5]. In addition the pharmaceutical intervention was classified according to whether an instruction for an administration was given, a drug was stopped/paused or changed, a new drug was started, and dosage or dosage form was changed.

The study was conducted in compliance with the requirements of the institutional review board, Philipps University, Marburg (Germany). All patients signed the informed consent.

Statistical analyses were performed using PASW 18 (Predictive Analytics Software, SPSS$^{TM}$ Inc). Descriptive data are shown as median and interquartile range (IQR) or mean ± standard deviation (SD).

## Results

### Baseline characteristics

Within 6 months 156 patients were recruited, one patient died during the hospital stay after study enrolment, and was disregarded for further evaluation. Patients' baseline characteristics are summarized in Table 1.

### DRPs and pharmaceutical interventions

The patients took on average 4.8 ± 3.4 (minimum 0; maximum 15) drugs on hospital admission and 6.9 ± 3.1

**Table 1** Baseline characteristics of 155 patients

| | | |
|---|---|---|
| Age, mean ± SD (years) | 70.7 ± 12.0 (min 32; max 92) | |
| Male sex, n (%) | 83 (53.5) | |
| Renal function eGRF (MDRD) (ml/min/1,73 m$^2$), n (%) | | |
| ≥60 | 112 (72.3) | |
| 30–59 | 40 (25.8) | |
| 15–29 | 2 (1.3) | |
| <15 | 0 | |
| Hemodialysis | 1 (0.6) | |
| Allergies (drugs), n (%) | | n/a |
| | 19 (12.3) | 21 (13.5) |
| Subtype of cerebral ischemia, n (%) | | |
| TIA | 33 (21.3) | |
| Ischemic stroke | 122 (78.7) | |
| Cardiovascular risk factors, n (%) | | n/a |
| Hypertension | 133 (85.8) | – |
| Diabetes | 45 (29.0) | – |
| Hyperlipidemia | 81 (52.3) | – |
| Atrial fibrillation | 49 (31.6) | – |
| Overweight/obesity (BMI > 25 kg/m$^2$) | 107 (69.0) | 4 (2.6) |
| Cigarette smoking | 34 (21.9) | 6 (3.9) |

*SD* Standard deviation, *n/a* not available

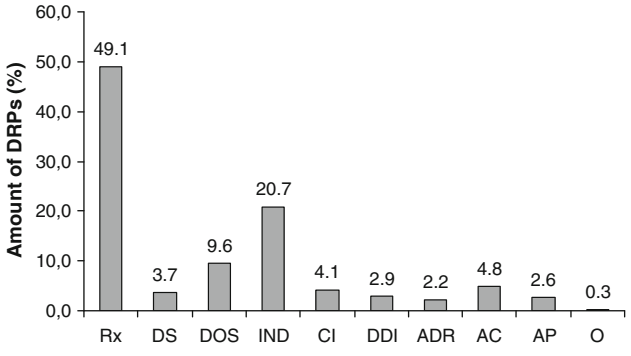


**Fig. 1** Distribution of the DRPs coded with APS-Doc in percent (%). *Rx* drug, *DS* dosage form/drug strength, *DOS* dosage, *IND* indication, *CI* contraindication, *DDI* drug–drug-interaction, *ADR* adverse drug reaction, *AC* administration/compliance, *AP* application, *O* other

(minimum 2; maximum 16) drugs at hospital discharge. In total, DRPs occurred in 105 of 155 (67.7 %) patients: Overall 271 DRPs were documented, with a mean of 1.8 ± 2.0 (minimum 0; maximum 10) DRPs per patient.

In 7.7 % of the cases DRPs were present on hospital admission, in 78.6 % of the cases a DRP occurred during the hospital stay, and 13.7 % of the DRPs were detected in the discharge letter.

The distribution of the main categories of DRPs coded by APS-Doc is shown in Fig. 1. DRPs occurred mainly in the categories "drug", "indication", and "dosage". The most frequent subcategories in the category "drug" were "transcription error/unintended discontinuation of drug therapy" [n = 49 (18.1 %)], "discontinuation of ambulatory medication" [n = 23 (8.5 %)], and "prescribing outside the formulary" [n = 22 (8.1 %)], in the category "indication" "drugs missing" [n = 36 (13.3 %)], and in the category "dosage" "dose to high" [n = 4 (3.7 %)], and inappropriate administration interval [n = 9 (3.3 %)]. DRPs with missing drugs were stroke-related in 80 % of the cases; these referred mainly to antihypertensive medication (undertreatment), secondary prevention (non-compliance with treatment guideline), and statin therapy (drug missing).

About 89 % of the pharmaceutical interventions were adopted by the physicians; the implementation of the remaining pharmaceutical interventions is unknown, because these were detected in the discharge letter and were not followed, if they were changed afterwards.

In more than 90 % of the cases the attending physicians were involved in resolving the DRP. Furthermore, nursing staff, patients and their caregivers, as well as the general practitioner were involved in resolving DRPs.

The most frequent pharmaceutical interventions which were carried out in response to a DRP were "drug was changed" (24.7 %), "a new drug was started" (19.6 %), "dosage was changed" (18.8 %), and "a drug was stopped/paused" (18.5 %).

## Discussion

This is the first study which has evaluated DRPs in patients with ischemic stroke from hospital admission to hospital discharge. The study demonstrates that DRPs may occur at any time in the prescribing process in the hospital, but actually occur mainly during the hospital stay, less on hospital admission or in the discharge letter. Data about the type, nature and frequency of DRPs in patients with ischemic stroke are limited. On average two-thirds of the documented patients were identified with at least one DRP. The rate of 1.8 DRPs per patient in the present study is comparable to a previous study conducted in the Department of Neurology [5]. Our data show that DRPs mainly occurred in the categories drug, indication and dosage. Investigating the subcategories in which DRPs occur, it becomes obvious that DRPs in the category drug and dosage may occur in any other patients as well [6]. DRPs in the category indication were mainly stroke-related and referred to antihypertensive medication, secondary prevention, and statin therapy, which were caused by undertreatment and non-compliance with treatment guidelines for ischemic stroke. In addition, there are many factors which are associated with increased risk to medication errors in stroke patients. These include advanced age, impaired communication because of aphasia, high prevalence of comorbidity, co-administration of multiple medications, use of intravenous route of administration because of impaired oral intake, administration of medications that require frequent laboratory testing and dose adjustments, and long hospital stay [4]. Michaels et al. [4] showed that medication errors are associated with drugs such as heparin, warfarin, antihypertensive medication, or the combination of antiplatelet drugs.

One main problem is the high rate of "transcription error or unintended discontinuation of drug therapy". Transcription errors are mainly caused by handwritten medical charts, partly with poor legibility of handwriting or simple inattention. These errors can be reduced by computerising the medication process, e.g. by using computerised physician order entry (CPOE) [1, 2, 7].

In fact, different kinds of medication discrepancies are common, particularly at discharge. Walker et al. [8] have shown medication discrepancy rates of up to 59 %. Furthermore, involving a clinical pharmacist in the discharge process can also contribute to a more complete medication list at discharge.

The total number of DRPs, and the frequencies of the various DRP categories vary among studies, depending on

the definition, methods and classification system used. Only 2 % of documented DRPs in our study were found to be "adverse drug reactions", which is a low result compared to other studies. A review of the literature from 1990 to 2005 found on average 8 % of hospitalized patients suffer from an adverse drug event [2].

The rate of adoption of the pharmaceutical interventions as recommended by the clinical pharmacist may serve as an indicator for the professional acceptance of the pharmacist's role. Our acceptance rate of 89 % seems to be consistent with other studies, which have reported rates between 83 and 93 % [6, 9, 10]. The high acceptance rate of the pharmaceutical interventions seems to indicate a high level of acceptance of the clinical pharmacist in the multidisciplinary team.

There are less data available about the nature of pharmaceutical interventions defined as any recommendation made with the intent of changing drug treatment. In our study pharmaceutical interventions were in about one quarter "drug was changed", followed by "a new drug was started", "a dosage was changed", and "a drug was stopped/paused".

### Limitations

One of the main limitations of this study was that it did not have a control group.

The study did not mainly focus on the drug distribution or administration process including preparation an infusion. Furthermore, the economic aspects of the role played by the clinical pharmacists in the health care team were not addressed in the study.

## Conclusion

In conclusion, DRPs are relatively common in hospitalised patients and may occur at any part of the prescribing process. The clinical pharmacist can provide a valuable contribution in the multidisciplinary team by detecting and resolving DRPs that lead to an optimized and safe pharmacotherapy in patients with ischemic stroke, especially regarding to antihypertensive medication, secondary prevention, and statin therapy.

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**Conflicts of interest** None.

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