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A clinical-pharmaceutical medication reconciliation with patient interview for a medication review to identify drug-related problems in elective patients during hospital admission

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Background and aim: Drug-related problems (DRPs), e.g. drug-drug interactions (DDI), can lead to adverse-drug reactions (ADRs) and thus complications during hospitalization. For this reason, such DRP, DDI and ADR should be identified and characterized as early as possible during hospital admission. We aimed to perform a clinical-pharmaceutical medication reconciliation in which patient-related information was collected and compared to drug-related information in a medication review. *Investigations:* During a 24-week-period, we consecutively invited patients electively admitted to Urology, Otolaryngology, Oral and Maxillofacial Surgery, General and Visceral Surgery, and Oncology Departments of a 300-bed hospital. A clinical pharmacist performed a patient interview asking for medication, ADR, and adherence. The medication reconciliation considered packages for a brown-bag analysis, medication lists, and data from the clinical information-system (CIS). In a medication review, we matched patient-related information to drug-related information from the drug label, guidelines, drug-databases and websites to identify DRPs. *Results:* In the study, 356 patients (median age: 58 years) taking 1,712 drugs participated. Of all patients, 7.3% reported ADR and 10.7% missing adherence. 5.3% brought packages that enabled a brown-bag analysis and 21.1% a medication list. In 76.7% of patients, information from CIS was incomplete or not up-to-date. Among the most frequently identified DRPs were "Medication without diagnosis" (31.2%) and "Inappropriate timing of administration" (11.5%). The proportion of patients affected by severe DDI ranged from 0.8%-16.6%, depending on the drug information source. *Conclusions:* Incomplete patient data, frequently identified DRPs and inconsistent drug-based information make pharmaceutical involvement in medication reconciliation on admission a necessity.

1. Introduction

Drug-related problems (DRP) can result in adverse drug reactions (ADR) (Tasaka et al. 2018) and clinical consequences e.g. prolongation of the hospital stay and irreversible damage to the patient (Westberg et al. 2018; Konuru et al. 2019). At interfaces of care such as admission (Garin et al. 2021) or discharge (Freyer et al. 2018), the potential for manifestation of such DRP is particularly high. DRP can even be the cause of a new hospital admission (Očovská et al. 2022). Therefore, DRP should be identified at this earliest stage of hospital treatment. In addition, strategies on admission and during hospitalization should also have an influence on discharge (Studer et al. 2023). Not only the specialist medication (Rouhi-Boroujeni et al. 2015) of the respective specialized departments or of particular patient groups (Sabry et al. 2016) should be considered, but the medication as a whole. Different drugs from different primary-care physicians can particularly often lead to drug-drug interactions (DDI) as a frequent cause of DRP. A medication reconciliation should collect all the necessary patient- and drug-related information at interfaces of care such as hospital admissions that can be utilized afterwards in a medication review to identify DRP. Such a medication review can be very well delegated to a clinical pharmacist. Despite the benefits, which have already been demonstrated in international studies (Hohl et al. 2017; Crotty et al. 2004; Renaudin et al. 2016, 2017; Mekonnen et al 2016) comparatively few data are available from Germany, especially from the outpatient sector (Seidling et al. 2021, Schulz et al. 2023). This may also be due to the fact that ward pharmacists have not yet been implemented to the same extent as in other countries and that interface problems are particularly obvious in Germany (Blümel et al. 2020). And even when such studies were performed here, they mostly addressed the setting of tertiary care hospitals also in other international settings (Abdulghani et al. 2018) and rarely other settings. Special hospitals such as those of the Bundeswehr, which also treat a considerable number of civilian patients,

Impact of findings on practice statements

- When elective patients are admitted to hospital, clinical-pharmaceutical medication reconciliation should be intensified by ensuring that patients bring their medication and medication list with them.
- A patient interview should be offered within a clinical-pharmaceutical medication reconciliation since it helps to close gaps in patient-related data in the clinical information system and additional aspects such as adverse drug reactions and adherence can be determined.
- For a clinical management, different drug-related information should be considered since such information can be contradictory.

have hardly been studied in this respect to date (Schiek et al. 2019; Wagner et al. 2023; Wildhagen et al. 2023). We aimed to perform a medication reconciliation, in which patient-related information was collected and compared to drug-related information in a medication overview.

2. Investigations and results

2.1. Ethics approval

A positive ethics vote was received by the Medical Faculty of the University of Leipzig (#183/22ek from May 24, 2022) and by the Research Commission of the Bundeswehr Hospital Hamburg. The patients' written informed consent was obtained. Participation was voluntary and could be discontinued at any time without giving a reason. No intervention such as a patient counseling was part of this study. However, if significant risks to the patient were identified, the treating physician was informed immediately for ethical reasons.

2.2. Study design

After patients gave their written informed consent, we performed a medication reconciliation considering patient-related information deriving from a patient interview conducted by a clinical pharmacist and from the clinical information system (CIS). We then matched this information in a medication review to drug-related information to identify pre-defined DRP. Additionally, we assessed ADR and adherence through the patient interview.

2.3. Participants and setting

Elective patients consecutively admitted to the Urology, Otolaryngology, Oral and Maxillofacial Surgery, General and Visceral Surgery, and Oncology Department were invited. The study was conducted during a 24-week period from May 30, 2022 to October 31, 2022 in a 300-bed military hospital including tertiary care for civilian (80% of beds due to the integration of the hospital in public healthcare- and emergency-services) and military patients (20% of beds).

2.4. Clinical-pharmaceutical medication reconciliation

The medication reconciliation included a patient interview, a brown bag analysis if drugs were brought to the interview, an assessment of medication lists and collecting patient-related information from the CIS.

- *Patient interview and brown bag analysis:* The patient interviews were conducted during normal duty hours in the central patient admission office in a separate room. Additional written information such as a physician letter and a medication list provided by the patient as well as drugs brought in (brown bag) during the interview were considered for the medication reconciliation. In addition to printed information, handwritten additions were also assessed. Reported administration problems were documented. Patients were asked for their self-assessed adherence and for observed ADR. The time required for the patient interview (without preparation and the follow-up) was documented. A previously created and piloted interview guide was used for the patient interview.
- *Medication lists:* During the patient interview, patients were asked whether they had a medication list with them. We documented whether the medication list was a Federal Medication List and whether the list was prepared by the patient himself, by a physician, or a pharmacist. We investigated whether any additions had been made and from whom.
- *Information from the clinical information system (CIS):* Patient's medication was collected from all available sources from the CIS such as physicians' letters, medical history forms, and premedication protocols.

2.5. Clinical-pharmaceutical medication review

The medication review was performed by the same clinical pharmacist who conducted the patient interview. All permanent, acute and on-demand drugs were included. Temporarily paused and in the last two weeks discontinued medication was also considered. All available patient-related data from the medication reconciliation were included for the medication review. We used the corresponding drug label (Summary of Product Characteristics, SmPC), guidelines (Institute for Patient Safety 2015), commercially available drug databases (#1-3) and websites/lists to analyze the medication claims to identify pre-defined DRP.

2.6. Pre-defined drug-related problems (DRP)

Patients with pre-defined drug-related problems (DRP) were assessed as main outcome variable. The following 10 categories of DRP were pre-defined. We orientated on relevant classifications in the literature (Schindler et al. 2021) and focused them on the following main categories:

1. *Diagnoses without drug:* We investigated whether diagnoses without corresponding drug therapy were recorded in the physician letters and in the CIS and compared these with the information in the guidelines.
2. *Drug without diagnoses:* We investigated whether drug therapies without corresponding diagnoses were recorded via the patient interview, in the medication plan, the physician letters and in the CIS and compared them to the information of the drug label.
3. *Lack of adherence:* We documented whether gaps in adherence were reported in the patient interviews and compared the information with the instructions for use in the drug label.
4. *Administration problems:* We documented whether administration problems were reported in the patient interview and compared the information given to drug label and drug databases.
5. *Contraindications not considered:* We matched the current medication with documented diagnoses from the physician letter and the CIS and compared it to the drug label.
6. *(Pseudo) double prescription:* We collected prescribed drugs as documented in the medication list, in the physician letters, and in the CIS and compared the information to drug databases.
7. *Possibly inappropriate drugs:* We collected drugs from all patient-related sources and compared them to the PRISCUS List (2010).
8. *Dosage:* We collected individual drug dosage from medication lists, physician letters, and in the CIS and compared them to the drug label and drug databases. Dosage deviations were divided into the subcategories "too low" and "too high" (both not considering impaired liver and renal function). As an additional subcategory was defined "not adjusted to impaired liver and renal function". Here, we reviewed the indicated dosages based on the organ function in the presence of impaired liver and renal function. Current laboratory data from medications lists, physician's letters, and the CIS were used as the basis for checking impaired liver and renal function. For the assessment of renal function, eGFR in mL/min was used. AST, ALT, and GGT in U/L were used when evaluating liver function. Information on dose adjustment and levels was obtained from the drug label.
9. *Inappropriate time of administration:* We documented whether the specified time of administration of all patient-related information sources was consistent with the information in the drug label and in the drug databases.
10. *Adverse drug reactions (ADR):* ADRs were documented when patients reported them in the patient interview. We compared the information to the drug label and drug databases.

2.7. Potential drug-drug interactions (DDI)

We collected potential DDI from all patient-related information sources. Three drug databases (Drug databases #1-3) were used to assess the patient-related information for DDI potentials. We classified the identified DDI according to their potential risk as follows:

- *Severe DDI:* In at least one of the investigated drug databases, potentially *serious* clinical consequences of the combination were indicated with the combination, which (frequently) could lead to prolonged hospitalization or irreversible damage. In most cases, appropriate clinical measures for avoidance were possible (*relatively contraindicated*). Only in rare cases no such measures were known, so that concomitant administration was considered *absolutely contraindicated*.
- *Moderate DDI:* In at least one of the contacted investigated drug databases, potentially *moderate* clinical consequences were indicated with the combination, which could only (in some cases) lead to short-term and reversible clinical symptoms. These were avoidable through appropriate clinical measures.

2.8. Statistics and data evaluation

We reported number of patients in absolute numbers and in percentage in the pre-defined (sub-)categories (i.e. DRP, ADR, and DDI). A descriptive statistical analysis was carried out for all items. For the patient age and the time required for the patient interview the median (Q50) and the 25%- (Q25) and 75%-quartiles (Q75) were calculated. Missing data in certain information sources was documented.

2.9. Potential sources of bias

A bias is mainly due to the fact that personal factors such as experience and prior knowledge cannot be completely ruled out when assessing information sources. For this reason, we pre-defined the categories with the help of an expert panel. In addition, all patients were interviewed by one and the same clinical pharmacist in order to standardize the patient interview as much as possible.

2.10. Study size

We considered a patient number of at least 300 patients to be appropriate, taking into account the heterogeneity of the admission departments, our experience with similar studies in the same setting in order to draw generalizable conclusions for our setting and to achieve feasibility in the time available.

2.11. Participants

In the course of the study, 356 patients were consecutively invited. All gave their written informed consent to participate in the medication reconciliation followed by the mediation review (response rate: 100%). No patient dropped out of the study. A total of 1,712 drugs were documented with a median of 4.8 drugs per patient. The patients were 58 years old (median, Q25: 42; Q75: 72) and a patient interview lasted 10 minutes (median, Q25: 5; Q75: 10).

2.12. Medication reconciliation

A total of 21.1% (75 of 356) patients had a medication list with them during the interview. Of those patients, 42.7% (32 of 75) took a medication list with them in the form of a Federal Medication List. Almost as many patients [37.3% (28/75)] had written their medication themselves as a listing and for 20.0% (15/75) a medication list had definitively prepared by a physician. Medication lists prepared through pharmacies were not found within this study. From the 75 medication lists brought, 30.7% (23/75) were complete when comparing data to the CIS and the patient interview. Most frequently additions were made by the patients [12.0% (9/75)]. Some additions were made by a physician [6.7% (5/75)] while additions from the pharmacy were not identified [0.0% (0/23)].

Of the patient-related information about medication, 91.9% (327/356) was obtained from the patient interview. Most of this information [90.2% (321/356)] was obtained exclusively by actively asking the patients. For 42.7% (152/356) of patients, information about the individual medication was already documented in the CIS. Of all patients, 5.3% (19/356) had their medication with them enabling a brown-bag analysis. In 69.4% (247/356), certain drugs were completely missing in the CIS. For 76.7% (273/356) of the patients, the respective information in the CIS was incomplete or not up-to-date when comparing this data to the medication lists and the information received through the patient interview. For 71.6% (255/356) information on at least one dosage of a drug was missing. For 71.6% (255/356) the exact time of administration of at least one drug was not documented.

2.13. Medication review

From the 10 pre-defined DRP categories, the three most common DRPs were first “Drugs without diagnosis” [31.2% (111/356)], second “Inappropriate time of administration” [11.5% (41/356)], and third “Lack of adherence” [10.7% (38/356)]. Adverse drug reactions (ADR) were identified in 7.3% (26/356). In no case immediate feedback to the treating physician was required due to a severe DRP. A presentation of all categories including the sources of patient- and drug-related information can be found in Table 1.

The proportion of patients affected by potential DDI ranged from 0.8% (3/356; Drug database #2) to 16.6% (59/356; Drug database #3) for severe DDI and from 34.0% (121/356; Drug database #3) to 35.4% (126/356; Drug database #1) for moderate DDI. Sources of information are presented in Table 2.

Table 1: Patients affected by one or more (several categories possible) of 10 categories of drug-related problems (DRP) and main sources of information to identify them in 356 consecutive patients with 1,712 taken drugs during elective hospital admission

#	Drug-related problems (DRP)	Main sources of patient-related information				Main sources of drug-related information				Identified frequency [percent (absolute numbers/ total)]
		Patient interview (including brown bag)	Medication list	Physican letters	Clinical information system (CIS)	Drug label	Guidelines	Drug databases (#1-3)	Websites	
1	**Diagnoses without drugs**			●	●		●			**5.1% (18/356)**
2	**Drugs without diagnoses**	●	●	●	●	●				**31.2% (111/356)**
3	**Lack of adherence**	●				●				**10.7% (38/356)**

4	**Administration problems**	●				●				**5.3% (19/356)**
5	**Contraindications not considered**			●	●	●				**3.4% (12/356)**
6	**(Pseudo) double prescription**		●	●	●			●		**2.2% (8/356)**
7	**Possibly inappropriate medication (PIM)**	●	●	●	●				●*	**3.1% (11/356)**
8	**Dosage ...**									
	... too low		●	●	●	●	●			**7.6% (27/356)**
	... too high		●	●	●	●	●			**2.0% (7/356)**
	… not adjusted to liver/renal function		●	●	●	●	●			**7.6% (27/356)**
9	**Inappropriate time of administration**	●	●	●	●	●	●			**11.5% (41/356)**
10	**Adverse drug reactions (ADR)**	●				●	●			**7.3% (26/356)**

*) PRISCUS List [24]

Table 2: Patients affected by one or more (several categories possible) of drug-drug interactions (DDI) and sources of information (commercially available drug databases #1-3) to identify them in 356 consecutive patients with 1,712 taken drugs during elective hospital admission

Drug-drug interactions (DDI)	Main sources of patient-related information				Sources of drug-related information			Identified frequency [percent (absolute numbers/ total)
	Patient interview (including brown bag)	Federal Medication Plan	Physican letters	Clinical information system (CIS)	Drug database #1	Drug database #2	Drug database #3	
Severe	●	●	●	●	●			**13.8% (49/356)**
	●	●	●	●		●		**0.8% (3/356)**
	●	●	●	●			●	**16.6% (59/356)**
Moderate	●	●	●	●	●			**35.4% (126/356)**
	●	●	●	●		●		**34.3% (122/356)**
	●	●	●	●			●	**34.0% (121/356)**

3. Discussion

3.1. Statement of key findings

The patient interview, in median lasting ten minutes, proved to be a rich source of information on individual drug therapy. A brown bag analysis was only possible in slightly more than 5% of the patients. For more than two thirds of patients, the information in the CIS was incomplete or not up to date. In particular, dosage information and information on the time of administration were missing. Only about one in five patients had a medication list with them. Less than half of those patients had a Federal Medication Plan. Only around a third of those plans proved to be complete when matched to the data from the CIS and information from the patient interview. In the medication review, pre-defined DRP occurred with a maximum of over 30%. The three most common DRP categories were "Drugs without diagnosis", "Inappropriate time of administration", and "Lack of adherence". ADRs were reported by around 7% of patients. The proportion of patients affected by potential DDI varied greatly depending on the drug information source and ranged from 0.8% to 16.6%.

3.2. Strengths and weaknesses

As a strength of our study, we enrolled a total of 356 consecutive patients with 1,712 taken drugs. We focused on hospital admission since especially here missing information can lead to clinical consequences for the individual patient in the further hospital treatment. Further, we performed a sophisticated medication reconciliation including a broad range of patient-related information. Besides contacting information from the CIS, even a comprehensive patient interview was performed. This was performed consecutively for all patients who were electively admitted to our hospital without focusing only on specific patient groups, indications, or drug classes. The medication reconciliation was followed by a medication review comparing the received information to a broad fraction of drug-related information sources in order to identify and evaluate discrepancies. It should be emphasized that we also recorded important clinical outcomes addressing ADR and adherence.

However, this study includes some limitations: Firstly, the survey was only conducted in one hospital. Secondly, the study did not yet include any solutions that were passed on to an attending physician or nursing staff, except in an emergency. Thirdly, despite the considerable number of patients enrolled, conclusions regarding generalizability should be drawn with caution, as the study focused only on patients admitted to hospital. Fourth, we assessed patient-reported adherence and did not confirm the reported results with validated questionnaires.

3.3. Interpretation

In our study we performed a medication review based on a comprehensive medication reconciliation to identify DRP. Risk factors facilitating clinical consequences from DRP have already been reported in literature (Jung-Poppe 2022) as intake of ≥ 8 drugs, drugs of the Anatomical Therapeutic Chemical (ATC) class N,

≥1 comorbidity, an estimated glomerular filtration rate (eGFR) <30 mL/min, and age ≥60 years. To prevent patients from harm, a pharmaceutical medication review can identify relevant DRP – as confirmed in our study – and even prevent DDI-related ADR (Bertsche et al. 2010), with the latter also being a valuable outcome of our study. Such a medication review helps to find solution and prevention approaches and to implement them in practice through an interdisciplinary collaboration (Gordon et al. 2018). Our findings are intended to provide strategies and sources for the effective implementation of a medication reconciliation and a medication review. However, in order for such a medication review to be effective in this sense, it is necessary that the information used is correct, complete and up-to-date by a sophisticated medication reconciliation (Al-Hashar et al. 2028; Redmond et al. 2028). Patient-related data on individual drug therapy as well as drug-related data that offers general information from clinical studies or approval are both required for a medication review as investigated in our study presented here.

3.4. Further research

As a consequence for future strategies, we can state that a pharmaceutical patient interview is excellently suited to close gaps in the medication profile in the sense of a medication reconciliation. This applies not only to general documentation gaps, but also to direct patient feedback, e.g., on ADR and adherence, which could hardly be assessed without the interview. Further patient-related data could be obtained through an increased use of a brown bag analysis. However, brown-bag analysis proved unlikely to be feasible in our setting since only few medications were brought in by the patient during the admission. This could be improved by better communication before the admission. Additional information, such as terminated drug use, DRP caused by use of drugs from family members, could be identified.

Indicated by the inconsistent results in the DDI assessment in this study, multiple sources of drug information should be considered to develop a coherent DRP solving strategy. Even if electronic support via digital clinical decision support systems is now essential for obtaining drug information, a personal medication assessment should be considered as part of an interdisciplinary collaboration. Only in this way, can we arrive at decisions together that can be implemented and make sense in individual patient situations. This is because many patient and drug-related factors need to be considered simultaneously and, what is more, these are not always consistent or complete.

3.5. Conclusion

On admission, information on patients' drug therapy was frequently incomplete. However, a medication reconciliation including a patient interview by a clinical pharmacist also considering medication lists brought by the patient, closed many of these gaps. Brought-in drugs that allowed brown-bag analysis, however, were a rarity. A medication review using different drug information sources enabled to identify numerous DRP. The pharmaceutical interview allowed to complete the medication profile with feedback on ADR and adherence directly reported by the patient. As shown for DDI, drug information sources can provide very inconsistent data.

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