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PharmVisit: Reducing medication-related problems through an interprofessional ward round process in acute geriatric care – a quality improvement project

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Summary

STUDY AIMS: Older adult patients admitted to hospital are often multimorbid, polymedicated and thus more susceptible to medication-related problems. To improve medication safety for this patient population, the University Hospital of Bern's Department of Geriatrics hosts clinical pharmacists on its ward rounds as part of an interprofessional collaboration project called PharmVisit. This study aimed to describe the interventions recommended by those clinical pharmacists and their rates of acceptance by physicians.

METHODS: The PharmVisit pilot project involved geriatricians and clinical pharmacists separately preparing for weekly ward rounds. Pharmacists used a checklist for medication reviews and the Swiss Association of Public Health Administration and Hospital Pharmacists (GSASA) classification tool for characterisation of recommendations. All patients residing on the ward during the study period were included. Outside the patient's room, clinicians and pharmacists, accompanied by a nurse, discussed the ongoing drug therapy and recommended beneficial medication adjustments resulting from the re-evaluation of treatment indications, potential drug-drug interactions, dose adjustments, optimised dosages and forms of administration, and medication omissions. Afterwards, all the parties, including the patient, discussed the medication changes at the bedside. Type and number of recommendations by clinical pharmacists were tabulated as primary outcomes. Acceptance rate as a secondary outcome was calculated based on the number of pharmacists' recommendations compared to the number of prescriptions adapted directly during ward rounds.

RESULTS: From July 2023 to April 2024, 46 ward rounds were documented, resulting in 480 recommended interventions for 221 patients. The top reasons for recommending interventions, categorised according to the GSASA tool, were dosing issues (17%), medication omissions (15%) and no apparent indication (13%). Clinical pharmacists made the most recommendations on issues involving pain medication (analgesics and opioids, 4% and 2%, respectively), laxative drugs (4%), proton-pump inhibitors (4%), hypnotics and sedatives (2%), and drugs for obstructive airway diseases (2%), reflecting the most problematic drugs identified in studies nationally and internationally.

The overall acceptance rate of PharmVisit recommendations was 54%. An additional 33% of recommended interventions were referred to a senior physician for a decision or to the primary care provider in the discharge letter. The most frequently and directly accepted intervention recommendations were optimising administration modalities (77%), medication exchange or substitution (71%) and medication discontinuation (62%).

CONCLUSION: This project emphasised how including clinical pharmacists in interprofessional ward round teams enabled the integration and consideration of more viewpoints on different aspects of drug therapies, facilitating a more critical debate on medication therapy decisions. Because older adult patients are at an elevated risk of medication-related problems, especially the high acceptance rate of deprescribing, recommendations suggest that PharmVisit is a meaningful means of reducing potentially inappropriate medications.

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Introduction

Older adult populations aged 75 or older are a particular challenge to daily medical care because of, among other things, the age-related physiological changes,characterised by impairment in the function of the many regulatory processes. Under the physiological stress that can occur in acute health conditions, homeostasis may not be maintained, leading to hospitalisation [1]. Medication-induced adverse effects may occur due to older adults' altered pharmacokinetics and pharmacodynamics. It is well documented that they are often prescribed medications that, though

safe for younger patients, are potentially inappropriate considering their age [2, 3]. Furthermore, older adult patients are often multimorbid, polymedicated, frail and cognitively impaired – all risk factors for medication-related problems (MRPs), which encompass (preventable) medication errors and adverse drug reactions. When admitted into inpatient care, interfaces between institutions and healthcare professionals pose the additional risk of information gaps that could lead to medication discrepancies and potentially hazardous treatment errors [4]. Data from a 2019 study in Switzerland by Giannini et al. found, through medication reconciliation, at least one discrepancy with every patient, with an average of three medications omitted. Indeed, they determined that 21% of the discrepancies were clinically relevant, and 19% of those were significant, i.e. had the potential to cause a mild-to-moderate adverse effect [5].

Although geriatricians undergo specialised training to treat patients with polypharmacy that benefits this group [3], interprofessional activities like pharmacist-accompanied ward rounds can further improve medication safety among hospitalised older adult patients. In a study conducted on two internal medicine wards in Switzerland, clinical pharmacists identified a mean of 2.6 medication-related problems per patient, mostly drug-drug interactions (21%), untreated indications (18%), overdosing (16%) and drugs used without a valid indication (10%) [6].

A study published by Blum et al. in the scope of the international OPERAM project did provide comparable findings of a mean of 2.75 START/STOPP recommendations based on interprofessional medication review in older adults, albeit from general internal medicine [7].

The University Hospital of Bern's Department of Geriatrics, therefore, agreed to host a pilot project – PharmVisit – and welcome clinical pharmacists on its weekly ward rounds. This project's overall goal was to optimise medication safety by identifying additional potential medication-related problems. We thus aimed to characterise the pharmacists' recommended interventions and determine physicians' acceptance rates for them.

Materials and methods

Setting

The Inselspital-University Hospital of Bern's Department of Geriatrics (in Switzerland), consisting of one ward, predominantly treats patients older than 70. Patients are usually admitted to other departments because of an emergency in the ambulatory or long-term care setting. To meet the criteria for admission to the Department of Geriatrics, patients must be diagnosed with a specific geriatric syndrome, e.g. a gait disorder, a cognitive, visual or hearing impairment, or polypharmacy. At the time of transfer, the patients still need in-hospital treatment and are not yet in a condition to be discharged due to different factors. Because patients' care has to cross different interfaces or undergo transitions of care, they are at a greater risk of medication-related problems. This is one of the reasons why the Department of Geriatrics welcomed the project's clinical pharmacists on weekly ward rounds. The ward is organised into three sectors of 8–10 beds, with average hospital lengths of stay of 7–14 days. During this time, patients receive a daily training plan that includes physiotherapy, occupational therapy and group activities that aim to maintain and promote their independence.

Intervention

The PharmVisit prospective quality improvement pilot study was conducted over the 11 months from the start of June 2023 to the end of April 2024, aiming for the inclusion of at least 145 patients and approximately 300 recommendations, assuming that at least two interventions per patient would be suggested, in order to have data with results comparable to a study performed in Switzerland earlier, albeit in internal medicine [6]. Clinical pharmacists attended interprofessional ward rounds approximately once per week. All had formal training in clinical pharmacy and at least one year of postgraduate professional experience.

The clinical pharmacists performed a systematic medication analysis of every eligible patient one day before the ward round based on the information in their electronic patient record and according to the Pharmaceutical Care Europe Networks (PCNE) definition of a Type 2b medication review [8]. For standardisation purposes, a checklist for medication review, based on the Medication Appropriateness Index [9], was provided to the clinical pharmacists (see appendix 1), who were supervised by a senior clinical pharmacist during their initial participation in the PharmVisit project.

Every patient on the participating geriatrics ward during the ward rounds prepared for by the clinical pharmacists was considered eligible for the project. No exclusion criteria were defined.

The hospital uses an electronic patient record system (EPIC, Epic Systems Corporation, https://www.epic.com) that is accessible to clinical pharmacists and enables PCNE Type 2b Advanced Medication Reviews [8].

PharmVisit ward rounds started with a discussion about the clinical pharmacist's recommendations outside the patient's room involving the physicians (mostly residents, but sometimes also a senior physician), the clinical pharmacist and a nurse. The discussion attempted to detect any medication-related problems like missing indications, dosing issues, drug-drug interactions, side effects, medication effectiveness and also covered adherence to guidelines, drug omissions and recommended interventions [8]. Recommendations were: accepted and noted directly in the EPIC system; *or* declined by the physicians present; *or* referred to senior physicians as topics for further discussion after the ward round; *or* delegated to the primary care physician in the discharge letter. Patients were also involved in the decision-making process. The PharmVisit process is shown in figure 1.

Intervention analysis and measurements

The clinical pharmacists documented the following items for each patient discussed during a PharmVisit ward round in a spreadsheet (Excel® for Microsoft Professional Plus 2016) according to the Swiss Association of Public Health Administration and Hospital Pharmacists (GSASA) classification system [10]: recorded problem, reason for intervention, the intervention suggested and the outcome pertaining to physician acceptance. In addition, they also tab-

ulated the drugs involved (using their Anatomical Therapeutic Chemical or ATC code) in a spreadsheet (Excel® for Microsoft Professional Plus 2016) [10]. The complete classification system is shown in appendix 2. French and German versions are available online from https://www.gsasa.ch.

Physicians documented ward rounds in the electronic patient record.

The following patient data were systematically recorded in a spreadsheet in Excel® (Microsoft Professional Plus 2016) after ward rounds: the patient's unique identification number, age, sex, number of comorbidities, diagnosis leading to hospital admission and number of medications. Outcome measures focused on descriptions of the clinical pharmacists' recommendations and their acceptance by physicians. A recommendation was considered accepted when the decision to do so was made during ward rounds. The corresponding entry in the patient file was verified before the next ward round by one of the pharmacists. Verification required the unique patient identification number in order to access the patient's electronic file. If the unique patient identifier was missing or wrong, the patient data could not be retrieved and it was considered missing data, leading to exclusion of that patient from our analysis. As a last step, patients were provided a consecutive number, anonymising the data irrevocably.

Analysis

Descriptive data analyses were performed in Excel®. Categorical variables were expressed using percentages, and continuous variables were reported using mean ± standard deviation (SD) and the median. We specifically analysed patient population characteristics pertaining to age and sex. We calculated the prevalence of the most common comorbidities. We counted regular and as-needed medications in order to calculate the extent of polypharmacy. The prevalence of the types of interventions suggested by pharmacists as well as their acceptance rate by physicians were tabulated. To characterise the pharmacists' interventions, we also conducted an exploratory descriptive data analysis.

A study protocol has not been published separately.

Ethical considerations

The present study was performed per the principles of the Declaration of Helsinki. The Cantonal Ethics Committee of Bern decided that an ethics review was not necessary as the study fell under the category of quality improvement projects and not under the Swiss Federal Human Research Act (ethics submission ID 2024-0056). This manuscript is structured according to the EQUATOR network's Standards for Quality Improvement Reporting Excellence (SQuIRE) guideline (https://www.equator-network.org) [11].

Results

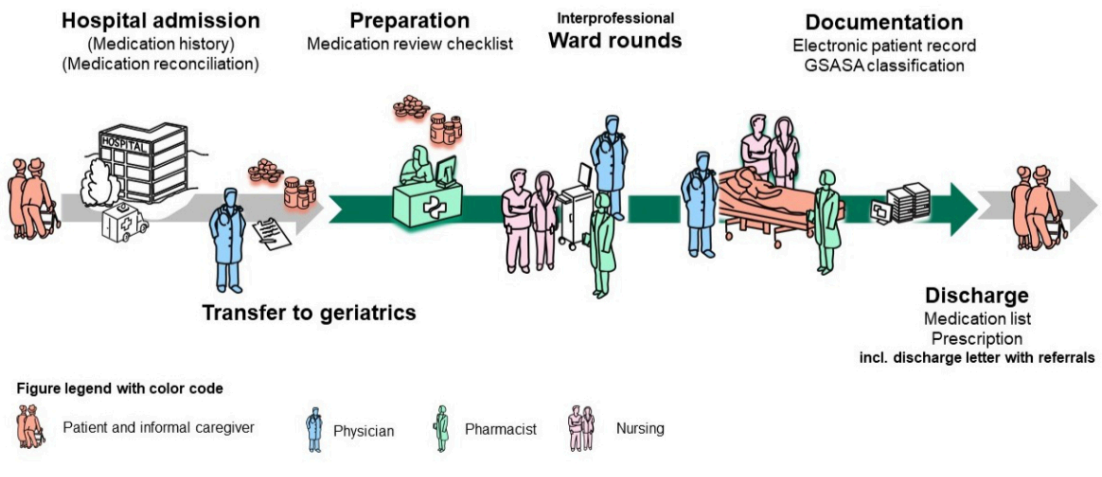
From June 2023 to April 2024, our clinical pharmacists recommended 480 potential medication interventions for 223 patients during 46 ward rounds. (Four additional patients were excluded due to missing or wrong patient identification numbers.)

The average patient age was 82, and 54% were men. Patients were predominantly transferred from the departments of General Internal Medicine (n = 129 or 58%), Neurology (n = 31 or 14%) and Orthopaedics (n = 20 or 9%). Patients had an average of 17 diagnoses (range: 6–42, median: 16). The top three diagnoses for admission to the geriatric ward were cerebrovascular events (n = 33 or 15%), fractures (n = 23 or 10%) and sepsis (n = 18 or 8%). Patients had a minimum of 2 and a maximum of 22 medications prescribed, with a median of 8. Patient characteristics are displayed in table 1.

In total, clinical pharmacists intervened 480 times. Patients had a mean of 2.2 interventions (median: 2, range: 1–9). Based on descriptive comparisons, the number of interventions did not differ between men and women. Similarly, no difference was observed when the data were stratified by the referring provider.

According to the GSASA classification system, the most common categories of recorded problems were "Risk due to treatment" (227/480 or 47.3%), "Effect of the treatment" (85/480 or 17.7%) and "Indication not treated" (76/480 or 15.8%).

Figure 1: Elements and sequence of the PharmVisit process.



In parallel, the three most prevalent reasons for identified interventions were classified as "Choice of dose", with 68 potentially too high and 35 potentially too low, totalling 103/480 (21.5%), "Other – omissions" (72/480 or 15.0%) and "Treatment without a clear indication" (64/480 or 13.3%). Details on the reasons for interventions are displayed in table 2.

The three intervention categories most commonly recommended by our clinical pharmacists were "Make dose adjustment" (104/480 or 21.7%), "Discontinue treatment" (102/480 or 21.3%) and "Start or restart medication" (79/480 or 16.5%). More intervention categories and their acceptance rates by prescribing physicians are presented in table 3. The recommended interventions with the highest rates of acceptance by physicians were "Optimise administration modality" (21/27 or 77.8%), "Substitute or exchange medication" (53/75 or 70.7%) and "Counsel or train patient" (5/8 or 62.5%), although this was a rare recommendation. Physicians' lowest rate of acceptance was for "Start or restart medication" recommendations (17/79 or 21.5%). The recommended interventions which most frequently needed clarification and a decision from a senior physician or were referred to the patient's primary care physician were "Clarification in the medical history" (39/53 or 73.6%) and "Change route of administration" (2/3 or 66.7%), although this was rarely an issue.

Based on the ATC's first-level codes, the medication groups most often addressed by PharmVisit's clinical pharmacists covered the following organ systems: A = alimentary tract and metabolism (70/480 or 14.6%), N = nervous

Table 1:
Description of characteristics of patients included in the PharmVisit project.

Patient characteristics		
Patients included, n (%)	In total	223 (100)
	Men	122 (55)
	Women	101 (45)
	Other	0 (0)
	Unknown	0 (0)
Patients excluded due to missing data, n/n total (%)		4/227 (1.8)
Age in years, mean (SD), median, range		82 (7), 83, 64–98
Prescribed medications per patient, mean (SD), median, range		9 (4), 9, 2–22
Number of diagnoses per patient, mean (SD), median, range		17 (5), 16, 6–42
Diagnoses per patient (ten most prevalent diagnoses), n	Cerebrovascular event	33
	Fracture	23
	Sepsis	18
	Fall	17
	Heart failure	13
	Pneumonia	12
	Polytrauma	8
	COPD exacerbation/Dyspnoea	7
	Pain	6
	Endocarditis	4

COPD: chronic obstructive pulmonary disease; SD: standard deviation.

Table 2:
Reasons for interventions recommended by the clinical pharmacists.

Reasons for interventions		**n (%)**
Choice of dose	Total	103 (21.5)
	Dose potentially too high	68 (14.2)
	Dose potentially too low	35 (7.3)
Other – Omissions		72 (15.0)
Treatment without a clear indication		64 (13.3)
(Drug-drug) interactions		44 (9.2)
Non-conformity with guidelines / potentially inappropriate medication (PIM)		40 (8.3)
Incomplete patient documentation		38 (7.9)
(Potential) adverse event		29 (6.0)
Unsuitable route/form of administration		21 (4.4)
Duplication		13 (2.7)
Contraindication		9 (1.9)
Inappropriate treatment duration		9 (1.9)
Inappropriate/missing monitoring		8 (1.7)
Insufficient knowledge of medical staff		5 (1.0)
Insufficient knowledge of the patient		3 (0.6)
Inappropriate timing or frequency of administration		2 (0.4)
Prescribed medication unavailable		1 (0.2)
Error in the medication use process		1 (0.2)
Other		18 (3.8)
Total interventions		480 (100)

system (68/480 or 14.2%) and C = cardiovascular system (36/480 or 7.5%). Other first-level codes were far less frequently involved in the issues raised by clinical pharmacists; they are available in appendix 3.

Clinical pharmacists made different interventions for different classes of drugs at ATC level 3 (see appendix 2 for more details). For acid-related drugs (A02), which were mainly proton pump inhibitors, pharmacists most often found that the drug was not indicated (n = 15 or 37%) or prescribed at too high a dose (n = 9 or 22%). For drugs used for diabetes (A10), pharmacists often found that treatments were missing (n = 9 or 38%). For analgesics (N02), pharmacists often found that doses were too high (n = 14 or 32%) or too low (n = 6 or 14%), or that they were a potentially inappropriate medication (n = 6 or 14%).

Discussion

The PharmVisit study piloted and successfully implemented an interprofessional ward round process to improve medication safety among older adult patients in an acute geriatric ward at the University Hospital of Bern. To the best of our knowledge, this was the first study in Switzerland to specifically explore clinical pharmacy services within the scope of daily ward rounds for such an older adult population.

Because of their multimorbidity, polypharmacy and frailty, older adult patients are at an elevated risk of medication-related problems [12]. Although a recent study in the USA suggested that geriatricians prescribed potentially inappropriate medications at lower rates than general internists [2], our clinical pharmacists nevertheless detected significant numbers of potential medication-related problems prescribed by the physicians collaborating in our project.

Interprofessional collaboration – acceptance rate

The average immediate acceptance rate of the interventions recommended by our clinical pharmacists during ward rounds was 54.2%, with 13.3% being rejected immediately and 32.5% being referred to senior physicians for a decision. This was slightly lower than in other interprofessional ward round projects executed in Switzerland: Reinau et al. reported an acceptance rate of 57.6% in 2019; however, that project addressed patients in a general internal medicine unit and patients' ages were not reported [13]. A 2015 study conducted in an internal medicine unit at Geneva University Hospitals reported an initial acceptance rate of 84% of recommendations, although the final rate of changes implemented was 58%. Patients in that study had a mean age of 68 ± 16 years (compared to our population's average of 82 ± 7 years), with greater polypharmacy (mean of 10.6 ± 4.0 medications per patient) than in our study (9 ± 4 medications).

Diverging recommendation acceptance rates might be explained by the different populations and settings in these studies. Our clinical ward rounds are also primarily attended by assistant physicians at the beginning of their clinical careers and with less clinical experience. This might explain why 32.5% of the interventions recommended did not receive an immediate decision during ward rounds but were referred to senior attending physicians for clarification and a decision or to the patient's primary care provider for a discharge letter. Decision-making and therapy adjustments might also have been made more difficult by shorter hospital lengths of stay and in cases of incomplete anamnestic medication information.

Potential need for multimodal interventions

Medication reconciliation – the process of "creating the most accurate list possible of all the medications a patient is taking and comparing that list against the physician's admission, transfer, and/or discharge orders with the goal of providing correct medications to the patient at all transition points within the hospital" [14] – is not yet performed systematically at the University Hospital of Bern. Before being admitted to the acute geriatric ward, patients go through at least one transition of care, and the involvement of other medical specialties during their stay can create additional interfaces, potentially leading to medication misinformation [15]. A study from the University Hospital of Basel demonstrated that combining medication reconciliation with interprofessional ward rounds accompanied by clinical pharmacists could significantly increase the detection of medication-related problems [16]. Therefore, expanding clinical pharmacy services to include medication reconciliation might improve the pertinence of any interventions recommended. This could optimise discharge processes for physicians, making prescribing more efficient and less error-prone [17].

Table 3:
Characteristics, frequency and acceptance rates of interventions recommended by clinical pharmacists during the PharmVisit pilot study.

Interventions recommended	Prevalence	Physician response to recommended intervention		
		Accepted	Referred	Rejected
Make dose adjustment, n (%)	104 (21.7)	62 (59.6)	26 (25.0)	16 (15.4)
Discontinue treatment, n (%)	102 (21.3)	63 (61.8)	34 (33.3)	5 (4.9)
Start or restart medication, n (%)	79 (16.5)	33 (41.8)	29 (36.7)	17 (21.5)
Substitute or exchange medication, n (%)	75 (15.6)	53 (70.7)	10 (13.3)	12 (16.0)
Clarification in the medical history, n (%)	53 (11.0)	9 (17.0)	39 (73.6)	5 (9.4)
Optimise administration modality, n (%)	27 (5.6)	21 (77.8)	2 (7.4)	4 (14.8)
Monitor therapy, n (%)	19 (4.0)	10 (52.6)	6 (31.6)	3 (15.8)
Counsel or train patient, n (%)	8 (1.7)	5 (62.5)	3 (37.5)	0 (0.0)
Inform healthcare professionals, n (%)	7 (1.5)	2 (28.6)	4 (57.1)	1 (14.3)
Change route of administration, n (%)	3 (0.6)	1 (33.3)	2 (66.7)	0 (0.0)
Make pharmacovigilance notification, n (%)	1 (0.2)	0 (0.0)	1 (100)	0 (0.0)
Other, n (%)	2 (0.4)	1 (50.0)	0 (0.0)	1 (50.0)
Total, n (%)	480 (100)	260 (54.2)	156 (32.5)	64 (13.3)

Characteristics of pharmacist recommendations

The most common reasons for the interventions recommended by pharmacists were the need for dose adjustments (21.7%) and medication omissions (15.0%). While the acceptance rate for dose adjustments was above average, at almost 60%, the immediate initiation or re-initiation of a medication was only accepted in 40% of cases.

Reinau et al. also reported dosing to be the most frequently addressed issue (24.0%) in ward rounds, comparable to our rate of 21.7% [13]. Guignard et al. reported that overdosage was identified in 16% of interventions, and subtherapeutic dosages were identified in another 8%, also adding up to 24% [6].

It is possible that pharmaceutical expertise is more developed and/or better accepted in certain clinical specialties. Increasing the participation of clinical pharmacists in routine ward rounds might improve levels of collaboration. We plan, therefore, to conduct a survey that will help to improve the acceptance and efficacy of PharmVisit processes as they transition to a routine part of clinical practice in our hospital.

The most commonly prescribed drug classes for elderly patients in Switzerland, as detailed in the 2017 Helsana Arzneimittelreport, were pain medication, proton-pump inhibitors and psycholeptics [18]. These drugs, plus laxatives and drugs for obstructive airway diseases, were also among the most common in our recommendations. The potential for preventing harm, specifically harm caused by pain medication (including analgesics, opioids and non-steroidal anti-inflammatory drugs), hypnotics and sedatives, was also highlighted in a recent publication by the World Health Organization. Its report also pointed out the vulnerabilities of patients aged 80 or older [19]. These findings might help to prioritise the patients most at risk and focus on especially harmful medications in case of staff shortages or limited resources in general.

While we did not measure our study's financial impact, a recent publication by Geneva University Hospitals detailed the return on investment of conducting ward rounds accompanied by clinical pharmacists. It found that inadequate dosing can cause mean extra costs of EUR 772 per medication-related problem [20]. In the present pilot study, the most frequent clinical pharmacist recommendation also addressed inadequate dosing, suggesting that the PharmVisit process could also be cost-effective.

Deprescribing is generally defined as "a systematic process of drug discontinuation, tapering or even substitution of inappropriate medications, supervised by a health care professional, with the goal of managing polypharmacy and improving outcomes" [21]. It can also contribute to safer and less costly medication therapies [22, 23]. In the present study, discontinuing a medication made up 21.3% of our recommendations, similar to the prevalence of 23.5% reported by Reinau et al. [13], and it was the second most frequently accepted recommendation, with a rate of 61.8%, well above our mean rate overall. Based on a study in a primary care setting, there is even potential to improve this rate if interprofessional collaboration for medication reviews and deprescribing is ongoing and encompasses, among other things, team-based training [24]. Within the scope of the PharmVisit project, clinical pharmacists have already started giving regular physician education sessions, emphasising the findings from the ward round project.

Limitations

This quality improvement study had some limitations. Due to limited staffing, our clinical pharmacists could only accompany ward rounds once per week and attend to a limited number of patients at the University Hospital of Bern's Department of Geriatrics. Due to those patients' lengths of stay, often lasting one to two weeks, 52 patients were present for more than one interprofessional ward round, potentially limiting the number of recommended interventions in the scope of follow-up visits. Due to the regular rotation of assistant physicians in a teaching hospital, some of the interventions recommended may have been redundant, and the learning curve of this constantly changing team may have been limited. However, this might make the contribution of clinical pharmacists all the more meaningful. We have also tried to counteract these issues by integrating clinical pharmacists into physician teaching sessions.

Recommended interventions by clinical pharmacists are based on a medication Type 2b review. While data exist that inpatient medication reviews can reduce hospital readmissions and emergency department visits, they have little to no effect on mortality and an uncertain effect on quality of life [25]. While the clinical pharmacists were trained for PharmVisit by the same senior pharmacist and used the same checklist as a basis, inter-rater reliability in performing medication reviews was not measured and so might have influenced the recommendations made by clinical pharmacists, depending on the professional attending the ward rounds.

The Swiss Association of Public Health Administration and Hospital Pharmacists (GSASA) classification system has no categories for detailing the reasons for rejections of pharmacists' recommendations. In addition, decisions on recommendations referred to senior physicians or the primary care providers were not necessarily recorded in the electronic patient record. Therefore, this information is missing in the data. An expansion of the GSASA classification system and an extended follow-up period should be considered in future studies.

While our study's generalisability may be limited, due to its single-site design, other projects in Switzerland involving clinical pharmacists have shown comparable outcomes [6, 12, 15].

The PharmVisit process is now being implemented in regular daily practice and extended to more sectors of the Department of Geriatrics. Additionally, we are planning to focus ward rounds on thematic issues commonly raised during the pilot phase, for example, medication to relieve chronic non-cancer pain. We are also considering earlier medication reconciliations once a unit transfer decision has been made, predominantly from general internal medicine to geriatrics.

Conclusion

Our project emphasised how including clinical pharmacists in interprofessional ward round teams enabled a con-

sideration of more viewpoints on the different aspects of a patient's drug therapy. This led to a more critical debate on medication therapy decisions, as reflected in the favourable acceptance rates for interventions recommended by clinical pharmacists. With older adult patients at an elevated risk of medication-related problems, the high acceptance rates for deprescribing and dose adjustment recommendations could be especially significant when it comes to reducing potentially inappropriate medications and subsequent adverse events. We will strive to improve the effectiveness of the PharmVisit process by expanding this service to more patients, integrating medication reconciliations into initial internal hospital transfers and advancing interprofessional education.

Data sharing statement

Study data are available from the authors upon reasonable request.

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Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest related to the content of this manuscript was disclosed.

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Appendix 1: Checklist for conducting a structured medication analysis with an action plan (translated with the help of www.deepl.com)

Step	Key question	Checklist (to tick off the steps carried out)	Aids
1. Documents	Are all documents available?	☐ Required documents: medication list, diagnosis list, laboratory values, vital parameters ☐ Additional documents: reports, assessments ☐ Medication reconciliation: recommended if: old medication list, hospital discharge and/or ≥2 prescribers	Therapy guidelines: • SURF-med (book) • www.awmf.org • www.akdae.de • www.msdmanuals.com/de • www.nhs.uk Dosage and risk calculator: • Opiates: www.usb.x-service.ch • GFR[2]: www.dosing.de • QT time: www.qtdrugs.org • Various: www.mdcalc.com Interactions: • www.compendium.ch (Login, incl. Beers list and GFR[2]) • HIV: www.hiv-druginteractions.org PIM[4] : • Priscus: www.gelbe-liste.de/rzneimitteltherapiesicherheit/priscus-liste • Beers: www.bcp.fu-berlin.de/pharmazie/faecher/klinische_pharmazie/arbeitsgruppe_kloft/materialien/Beers-Liste.pdf • Start/Stopp: www.ncbi.nlm.nih.gov/pmc/articles/PMC4339726/ (Supplementary Materials) Therapeutic monitoring: • www.laborlexikon.de ADRs[1] : • Meyler's Side Effects of Drugs (online book) • Lungs: www.pneumotox.com • Liver: www.livertox.nih.gov OTC[3] : • www.mayoclinic.com/drugs • www.nccih.nih.gov/health/herbsataglance
2. Indication	Does every diagnosis have a therapy?	☐ Under-treatment: missing diagnoses and diagnoses without therapy ☐ Over-treatment: therapy without diagnosis and duplication	
3. Administration	Are the dosage, intake interval, time, dosage form and duration of therapy appropriate?	☐ Dosing: appropriate and adapted to risk factors (see Safety) ☐ Simplification: interval, time, dosage form, whole tablets if possible, medical aids ☐ Time: adapted to meals, circadian rhythm and risk of ADRs [1] ☐ Duration: chronic, temporary or on demand	
4. Safety	Is there an increased risk of ADRs ?[1]	☐ Risk factors: Age, diagnoses, allergies, alcohol, nicotine, GFR[2] , high-risk and OTC[3] medications ☐ Interactions: with medication, diagnoses or food ☐ High risk medications: monitoring available, clarify potential misuse and overdose ☐ ADRs[1]: ≥2 drugs with the same ADR[1], PIM[4] , potential prescribing cascade	
5. Effectiveness	Are the therapies effective and monitored?	☐ Evidence: treated according to current therapy guidelines ☐ Goals: symptom control, clinical markers and/or prevention of progression/exacerbation ☐ Monitoring: available and appropriate	
6. Client	How is the client integrated into the therapy?	☐ Adherence: medication taken according to plan or do not take according to plan ☐ Concerns: costs, handling and swallowing problems and ADRs[1] ☐ Knowledge: diagnosis, medication, goals, priorities and ADRs[1] ☐ Wishes: life expectancy, quality of life and risk-benefit analysis	
7. Costs	Are there more cost-effective alternatives?	☐ Consider: effectiveness, appropriateness and efficiency ☐ Pharmacology: generic, combination product, pack size and only one strength ☐ Non-pharmacological: reduce/stop alcohol and nicotine consumption, exercise, diet and nutrition	
8. Nursing staff	How are the nursing staff involved in the therapy?	☐ Medication management: not involved, setting up the weekly dosing system, providing the medication and/or help with taking/using it ☐ Options: demonstration of the devices, teach back, motivational interviewing	
9. Interventions	Which interventions bring the greatest benefit?	☐ Prioritization: high, medium ot low; from greatest benefit / least harm to least benefit / greatest harm ☐ Changes: reduce/stop only one medication at a time and monitor condition ☐ Consider: withdrawal symptoms, addiction and relapse potential	
10. Communi-cation	Which interventions are forwarded?	☐ Consent: obtain information from clients/relatives and care professionals ☐ Interventions: with the highest prioritization and e.g. forward a maximum of 5 simultaneously ☐ Contact person: assign doctor, pharmacist, nursing staff or client/relatives ☐ Mode of communication: use of a standardized process	

No.	Medication/diagnosis	Medication-related problem	Recommendation/comment	Prioritization high, medium, low	Contact person physician, pharmacist, nursing staff, client/relatives
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
...					

Appendix 2: GSASA intervention sheet including instructions

Source: www.gsasa.ch/de/aktivitaeten/pharmazeutische-dienstleistungen/klinische-aktivitaeten
Translated with the support of Deepl pro (www.deepl.com, 30.11.2024)

1. Pharmaceutical intervention sheet (version 3, 2021)

Date :

Medication :

DIVISION

- ☐ 1) Medicine
- ☐ 2) Surgery
- ☐ 3) Geriatrics
- ☐ 4) Orthopedics
- ☐ 5) Psychiatry
- ☐ 6) Adult intensive care
- ☐ 7) Pediatric intensive care
- ☐ 8) Pediatrics
- ☐ 9) Rehabiliation
- ☐ 10) Other…

1) RECORDED PROBEM

- ☐ 1) Effect of the treatment
- ☐ 2) Indication not treated
- ☐ 3) Risk due to treatment
- ☐ 4) Treatment costs
- ☐ 5) Missing / faulty documentation
- ☐ 6) Correct, but not optimal therapy regimen
- ☐ 7) Other…

2) REASON FOR THE INTERVENTION (tick ONE option per section)

Choice of treatment:

- ☐ 1a) Contraindication
- ☐ 1b) Drug not indicated
- ☐ 1c) Duplication
- ☐ 1d) Interaction
- ☐ 1e) Adverse event
- ☐ 1f) Incomplete patient documentation
- ☐ 1g) Non-conformity with guidelines / potentially inappropriate medication PIM

Choice of galenic form:

- ☐ 2) Unsuitable route/form of administration

Choice of dose:

- ☐ 3a) Dose too low
- ☐ 3b) Dose too high
- ☐ 3c) Inappropriate/missing monitoring

Therapy duration:

- ☐ 4 Inappropriate therapy duration

Medication use:

- ☐ 5a) Treatment not received
- ☐ 5b) Inappropriate timing or frequency of administration

Logistics:

- ☐ 6a) Prescribed medication unavailable
- ☐ 6b) Error in the medication use process

Other:

- ☐ 7a) Insufficient knowledge of medical staff
- ☐ 7b) Insufficient knowledge of the patient
- ☐ 7c) Other…

Patient documentation *(only in case of medication reconciliation!)*

- ☐ 8a) Drug not recorded in patient documentation
- ☐ 8b) One too many drugs on the medication list
- ☐ 8c) Wrong drug name recorded, incl. generics
- ☐ 8d) Duplication – generic or therapeutic
- ☐ 8e) Incorrect strength, dosage, frequency, route
- ☐ 8f) Medication duration incorrectly documented / absent
- ☐ 8g) (Other) incorrect / incomplete patient documentation

3) INTERVENTION

(tick ONE option)

- ☐ 1) Start / restart of treatment
- ☐ 2) Discontinuation of treatment
- ☐ 3) Substitution / exchange
- ☐ 4) Dose adjustment
- ☐ 5) Therapy monitoring
- ☐ 6) Change in the route of administration
- ☐ 7) Optimization of administration modalities
- ☐ 8) Informing healthcare professionals
- ☐ 9) Patient counselling, training
- ☐ 10) Clarification in the medical history
- ☐ 11) Pharmacovigilance notification
- ☐ 12) Other…

4) RESULT OF THE INTERVENTION (tick ONE option)

- ☐ 1) (Therapy) Change made
- ☐ 2) (Therapy) Change not made
- ☐ 3) Clarification initiated
- ☐ 4) Course unknown
- ☐ 5) Not applicable

5) COMMUNICATION OF THE INTERVENTION

(multiple answers possible)

- ☐ 1) Verbally during ward rounds
- ☐ 2) Verbally during chart review
- ☐ 3) In writing (email) without personal contact
- ☐ 4) Note in patient documentation
- ☐ 5) Missing / faulty documentation
- ☐ 6) Correct, but not optimal therapy regimen
- ☐ 7) Other…

GSASA_Intervention_sheet_clinical_pharmacy_V3_2021_en

2. Instructions for the GSASA classification system for the documentation of clinical interventions with examples

Code	Category	Code	Subcategory	Description of the subcategory	Examples
1	**Recorded Problem**	1.1	Effect of the treatment	Any problems or circumstances that may alter the effectiveness of a medicine, or any signs or symptoms that indicate lack of or unsatisfactory effectiveness	No effect of quinolone therapy due to the formation of non-absorbable complexes with polyvalent cations
		1.2	Indication not treated	Preventive, therapeutic or concomitant medication not prescribed for an existing indication	No laxative prescribed as concomitant medication for opioid therapy
		1.3	Risk due to treatment	Any problems or circumstances that may place the patient at increased risk of adverse drug reactions, or any signs or symptoms indicating a lack of or inadequate drug safety	Risk of torsades de pointes due to the combination of amiodarone and clarithromycin
		1.4	Treatment costs	Any question relating to the cost of drug treatment (e.g. high price, reimbursement, cost-effectiveness, economic situation of the patient, generic substitution)	Switch from the original preparation to the generic (generic substitution) due to low treatment costs; i.v. administration of antibiotics longer than clinically necessary
		1 5	Incorrect / missing patient documentation	Existing or non-existing information in the patient documentation that leads or could lead to misinformation or misconduct	The patient is taking medication that is not listed in their medication list
		1.6	Correct, but not optimal therapy regimen	All problems that are based on regulations that are basically correct but not optimal	According to the prescription, the patient must take Belok Zok® twice a day, but it could be administered in one daily dose
		1.7	Other	All problems that cannot be classified using the above categories	-

V3_2021

Code	Category	Code	Subcategory	Description of the subcategory	Examples
2	**Reason for intervention**	*Choice of treatment*			
		2.1a	Contraindication	Patient has a relative or absolute contraindication to the therapy	Metformin is contraindicated in patients with severe renal insufficiency
		2.1b	Drug not indicated	Use of a drug without indication	Potassium substitution despite normal blood levels.
		2.1c	Duplication	Inappropriate or unintended use of two drugs from the same therapeutic class	Combination of ACE inhibitor and Sartan
		2.1d	Interaction	The combination of a drug with another drug or with food that causes a potential or manifest adverse outcome	Calcium in combination with levothyroxine
		2.1e	Undesirable effect	response to a medicinal product that is harmful and unintended and occurs at doses normally used in humans for the prophylaxis, diagnosis or treatment of disease or for the modification of physiological function	Tremor as a sign of lithium toxicity
		2.1f	Incomplete patient documentation	Lack of information on diagnoses, therapies and/or progression	Allergies are not entered in the patient dossier or medication lists are not complete
		2.1g	No compliance with the guidelines or potentially inadequate medication (PIM)	Drug selection does not comply with current treatment guidelines or is not adequate due to patient characteristics (e.g. age)	ASA is not prescribed for post-infarction patients according to guidelines, anticholinergics in elderly patients
		Choice of galenic form			
		2.2	Unsuitable route/form of administration	Incorrect route or method of administration, or incorrect formulation, or incompatibilities	Delayed release tablets are crushed for administration by gastric tube
		Choice of dose			
		2.3a	Dose too low	All dosages that were selected too low for the corresponding situation (incl. due to altered kidney functions, etc.)	Pantoprazole 20 mg for duodenal ulcer
		2.3b	Dose too high	All dosages that were set too low for the corresponding situation (incl. due to changes in kidney function, etc.)	Prescribed dose of paracetamol exceeded the maximum daily dose.

Code	Category	Code	Subcategory	Description of the subcategory	Examples
		2.3c	Inappropriate / missing monitoring	Inadequate or missing process of monitoring, recording and recognizing the effects or safety of a therapy, incl. therapeutic drug monitoring	No control of thyroid hormones in the case of substituted hypothyroidism. Incorrect timing of blood sampling for determining the serum level of a drug
		Duration of treatment			
		2.4	Inappropriate duration of treatment	Therapy duration too long or too short	Folic acid substitution despite adequate serum levels, antibiotic therapy too short, topical application of a cortisone cream too long
		Use of the medication			
		2.5a	Treatment not received	Any problem or circumstance that prevents the patient from receiving the treatment originally prescribed	The nurse has forgotten to give a prescribed dose
		2.5b	Unsuitable time or frequency of administration	Incorrect timing of medication intake with regard to circadian rhythm or food intake, or non-adherence to the dosing interval	Taking bisphosphonates with breakfast, nitrate-free interval for nitroglycerin patches is too short
		Logistics			
		2.6a	Prescribed medication not available	Medication not in stock, stock shortage or other logistical problems in the supply of medicines	Medication prescribed but not in stock
		2.6b	Errors in the medication process	Any error in drug prescription, transcription, distribution or administration	No transfer of the indicated medication from the prescription sheet to the patient file (transfer error)
		Other			
		2.7a	Insufficient knowledge of medical staff	Nursing staff/doctors lack information about medication or illnesses	Doctor is not aware of a drug interaction
		2.7b	Insufficient knowledge of the patient	Patient lacks information about their medication or illnesses	Patient does not know how to use an asthma inhaler
		2.7c	Other	All reasons that cannot be classified with the previously mentioned categories	-

Code	Category	Code	Subcategory	Description of the subcateaory	**Beisoieile**
		Patient documentation (only use categories as part of systematic medication reconciliation (MedRec))			
		2.8a	Medication not recorded in the patient documentation	A medication that the patient uses but is not recorded in their patient documentation	The patient is using Timoptic®, which is not included in the medication list.
		2.8b	Too much medication recorded in the patient documentation	A medication that is recorded in the patient documentation but is not used by the patient.	Atorvastatin, which the patient is no longer taking but is included in the medication list.
		2.8c	Name of drug entered incorrectly, incl. generic	The name of a medication is entered incorrectly in the patient documentation	Meto Zerok® is listed instead of Beloc Zok® on the medication list
		2.8d	Generic or therapeutic duplication	Inappropriate or unintended use of two drugs from the same therapeutic class	The patient takes Nexium® and Pantozo® at the same time
		2.8e	Strength, dosage, dosage regimen, frequency, route of administration incorrectly documented / missing	The strength, dosage, frequency or route of administration of a medication that the patient is taking is incorrectly documented or missing from the patient documentation	The patient must take 20mg pantoprazole daily, although the medication list states 40mgi
		2.8f	Medication duration incorrectly documented/missing	The duration of therapy with a drug that is not usually given as long-term therapy is incorrectly documented or not documented at all	It is not noted how long the patient still has to take an antibiotic
		2.8g	(other} incorrect/ incomplete patient documentation	All other errors in patient documentation that cannot be classified using the above categories	Discrepancies in allergies and intolerances

Code	Category	Code	Subcategory	Description of the subcategory	Examples
3	**Intervention**	3.1	Start / restart of treatment	Introduction of a medication to the treatment plan	Restart of oral anticoagulants after bridging with heparin
		3.2	Discontinuation of treatment	Discontinuation of a medication without substitution by another medication	Discontinuation of a proton pump inhibitor that was prescribed without indication / risk factors.
		3.3	Substitution / exchange	Replacement of one drug by another for the same indication	Change from esomeprazole to pantoprazole
		3.4	Dose adjustment	Adjusting the dose of medication or duration of therapy in relation to medical and personal conditions	Reduction of the enalapril dose due to renal insufficiency
		3.5	Therapy monitoring	Monitoring, recording and recognizing the effects of a drug administered to an individual for verification purposes of safety or efficacy, incl. therapeutic drug monitoring	Recommendation of a laboratory determination of uric acid in suspected gout, recommendation of therapeutic drug monitoring in a patient treated with Vancomvcin.
		3.6	Change in the route of administration	Change to a suitable route of administration of the medication	Change from i.v. antibiotic therapy to oral therapy
		3.7	Optimization of the administration modalities	Adaptation of the treatment plan to the patient or optimization of the response to the medication, e.g. taking into account the distance to meals; posture, taking on an empty stomach, difficulty swallowing	Recommendation to take bisphosphonates on an empty stomach and in an upright position
		3.8	Information for medical staff	Informing nursing staff/doctors about a problem or circumstance	Explanation of a possible drug interaction
		3.9	Patient counseling, training	Advice and/or training for patients about their medication	Instruction on the use of an asthma dosing spray
		3.10	Clarification in the medical history	Additions or corrections to the patient file	Clarification of a prescribed medication without indication in the patient dossier
		3.11	Pharmacovigi!ance message	Report of an adverse drug reaction to a reporting body / health authority	Report of a case: of metamizole-induced agranulocytosis
		3.12	Other	All interventions that cannot be classified using the above categories	-

Code	Category	Code	Subcategory	Description of the subcategory	Examples
4	**Result of the intervention**	4.1	(Therapy) change takes place	A (therapeutic) change has taken place as a result of the intervention	Dose, which was too high, is reduced, an ECG, which would be indicated according to the pharmacist, was ordered
		4.2	(Therapy) change not made	Despite the intervention, no (therapeutic) change has taken place	Medication without indication is continued without clarification
		4.3	Clarification initiated	Inadequate or missing information is clarified (with other people or in the patient documentation)	The doctor clarifies with the family doctor whether there is an indication for a particular medication; an assistant doctor clarifies an intervention with the senior physician
		4.4	Course unknown	Result of the intervention not known	No feedback received after a written recommendation
		4.5	Not applicable	Intervention does not require acceptance or implementation	Transmit information to the doctor

Appendix 3

Overview of medication classes involved in potential medication related problems adressed by clinical pharmacists during PharmVisit, characterized by the Anatomical Therapeutic Chemical (ATC) classification system, according to the World Health Organization WHO www.who.int/tools/atc-ddd-toolkit/atc-classification

Organ System	**ATC Level 1** N (%)	**ATC Level 3**	**Most common interventions**	**Frequency (Accepted, Deferred, Rejected, Not applicable)**
A Alimentary tract and metabolism	147 (33%)	Drugs for acid related disorders (A02)	Drug not indicated	15 (9, 5, 1, 0)
			Dose too high	9 (2, 5, 2, 0)
			Interaction	5 (4, 1, 0, 0)
			Adverse event	4 (3, 1, 0, 0)
			Contraindication	2 (2, 0, 0, 0)
			Dose too low	2 (1, 1, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	2 (1, 0, 1, 0)
			Duplication	1 (1, 0, 0, 0)
			Treatment not received	1 (1, 0, 0, 0)
		Drugs for functional gastrointestinal disorders (A03)	Interaction	9 (6, 2, 1, 0)
			Dose too high	2 (2, 0, 0, 0)
		Antiemetics and antinauseants (A04)	Non-conformity with guidelines / potentially inappropriate medication PIM	3 (3, 0, 0, 0)
			Insufficient knowledge of medical staff	2 (1, 1, 0, 0)
			Duplication	1 (1, 0, 0, 0)
			Drug not indicated	1 (1, 0, 0, 0)
		Drugs for constipation (A06)	Dose too high	7 (7, 0, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	7 (6, 1, 0, 0)
			Inappropriate therapy duration	5 (5, 0, 0, 0)
			Duplication	4 (3, 1, 0, 0)
			Treatment not received	3 (2, 0, 1, 0)
			Dose too low	3 (2, 0, 1, 0)
			Drug not indicated	2 (2, 0, 0, 0)
			Adverse event	2 (2, 0, 0, 0)
			Contraindication	1 (1, 0, 0, 0)

		Antidiarrheals, Intestinal Antiinflammatory/Antiinfective agents (A07)	Dose too high	1 (1, 0, 0, 0)
		Drugs used in diabetes (A10)	Treatment not received	9 (5, 4, 0, 0)
			Drug not indicated	6 (6, 0, 0, 0)
			Other	2 (2, 0, 0, 0)
			Dose too low	2 (2, 0, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	2 (1, 1, 0, 0)
			Dose too high	1 (1, 0, 0, 0)
			Error in the medication use process	1 (1, 0, 0, 0)
			Unsuitable route/form of administration	1 (0, 0, 0, 1)
		Vitamins (A11)	Treatment not received	4 (1, 1, 2, 0)
			Drug not indicated	1 (1, 0, 0, 0)
			Contraindication	1 (1, 0, 0, 0)
			Other	1 (1, 0, 0, 0)
			Dose too high	1 (0, 0, 1, 0)
			Drug not recorded in patient documentation	1 (0, 0, 0, 1)
		Mineral supplements (A12)	Treatment not received	6 (2, 2, 1, 0)
			Drug not indicated	3 (3, 0, 0, 0)
			Dose too high	2 (2, 0, 0, 0)
			Interaction	2 (2, 0, 0, 0)
			Inappropriate/missing monitoring	2 (0, 1, 1, 0)
			Adverse event	1 (1, 0, 0, 0)
			Contraindication	1 (1, 0, 0, 0)
			Incorrect strength, dosage, frequency, route	1 (0, 1, 0, 0)
			Duplication	1 (0, 1, 0, 0)
			Unsuitable route/form of administration	1 (0, 0, 1, 0)

B Blood and blood forming organs	33 (7%)	Antithromobotic agents (B01)	Treatment not received	7 (2, 2, 3, 0)
			Dose too high	5 (2, 1, 2, 0)
			Drug not indicated	4 (1, 3, 0, 0)
			Dose too low	3 (1, 1, 1, 0)
			Incomplete patient documentation	3 (0, 3, 0, 0)
			Unsuitable route/form of administration	2 (2, 0, 0, 0)
			Other	2 (1, 0, 1, 0)
			Interaction	1 (1, 0, 0, 0)
			Duplication	1 (1, 0, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	1 (0, 1, 0, 0)
		Antianemic preparations (B03)	Dose too high	2 (2, 0, 0, 0)
			Interaction	1 (1, 0, 0, 0)
			Inappropriate therapy duration	1 (0, 0, 1, 0)
C Cardiovascular system	57 (13%)	Cardiac therapy (C01)	Drug not indicated	1 (1, 0, 0, 0)
			Duplication	1 (0, 1, 0, 0)
		Antihypertensives(C02)	Adverse event	1 (0, 0, 1, 0)
		Diuretics (C03)	Contraindication	2 (2, 0, 0, 0)
			Dose too high	2 (1, 1, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	2 (0, 0, 2, 0)
			Inappropriate/missing monitoring	1 (1, 0, 0, 0)
			Dose too low	1 (1, 0, 0, 0)
			Interaction	1 (0, 1, 0, 0)
			Treatment not received	1 (0, 1, 0, 0)
			Incomplete patient documentation	1 (1, 0, 0, 0)
		Beta blocking agents (C07)	Treatment not received	3 (0, 2, 1, 0)
			Dose too low	2 (2, 0, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	2 (1, 0, 1, 0)
			Adverse event	2 (1, 1, 0, 0)
			Inappropriate timing or frequency of administration	1 (1, 0, 0, 0)
			Incorrect strength, dosage, frequency, route	1 (1, 0, 0, 0)

		Calcium channel blockers (C08)	Unsuitable route/form of administration	1 (1, 0, 0, 0)
			Dose too high	1 (1, 0, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	1 (0, 1, 0, 0)
		Agents acting on the renin-angiotensin system (C09)	Adverse event	4 (2, 0, 2, 0)
			Dose too high	4 (0, 3, 1, 0)
			Dose too low	3 (1, 1, 1, 0)
			Unsuitable route/form of administration	2 (2, 0, 0, 0)
			Inappropriate timing or frequency of administration	1 (1, 0, 0, 0)
			Incomplete patient documentation	1 (1, 0, 0, 0)
			Treatment not received	1 (0, 1, 0, 0)
		Lipid modifying agents (C10)	Treatment not received	4 (3, 0, 1, 0)
			Interaction	3 (2, 1, 0, 0)
			Contraindication	2 (2, 0, 0, 0)
			Unsuitable route/form of administration	1 (1, 0, 0, 0)
			Incorrect strength, dosage, frequency, route	1 (0, 0, 1, 0)
			Drug not indicated	1 (0, 1, 0, 0)
			Treatment not received	1 (1, 0, 0, 0)
D Dermatologicals	4 (1%)	Antifungals for dermatological use (D01)	Inappropriate therapy duration	1 (1, 0, 0, 0)
			Insufficient knowledge of medical staff	1 (1, 0, 0, 0)
		Emollients and protectives (D02)	Treatment not received	1 (1, 0, 0, 0)
		Antiseptics and disinfectants (D08)	Treatment not received	1 (0, 0, 1, 0)
G Genito urinary system and sex hormones	24 (5%)	Sex hormones and modulators of the genital system (G03)	Drug not indicated	4 (0, 2, 2, 0)
			Treatment not received	1 (1, 0, 0, 0)
		Urologicals (G04)	Incomplete patient documentation	4 (0, 4, 0, 0)
			Other	2 (2, 0, 0, 0)
			Treatment not received	2 (1, 1, 0, 0)
			Drug not indicated	2 (1, 1, 0, 0)
			Adverse event	2 (0, 1, 1, 0)

			Incorrect strength, dosage, frequency, route	1 (1, 0, 0, 0)
			Duplication	1 (1, 0, 0, 0)
			Dose too high	1 (1, 0, 0, 0)
			Interaction	1 (0, 1, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	1 (0, 1, 0, 0)
			Unsuitable route/form of administration	1 (0, 1, 0, 0)
			Dose too low	1 (0, 1, 0, 0)
H Systemic hormonal preparations, excl. Sex hormones and insulins	7 (2%)	Corticosteroids for systemic use (H02)	Treatment not received	1 (0, 1, 0, 0)
			Drug not indicated	1 (0, 1, 0, 0)
		Thyroid therapy (H03)	Incomplete patient documentation	2 (1, 1, 0, 0)
			Interaction	1 (1, 0, 0, 0)
			Incorrect strength, dosage, frequency, route	1 (1, 0, 0, 0)
			Dose too high	1 (1, 0, 0, 0)
J Antiinfectives for systemic use	8 (2%)	Antibacterials for systemic use (J01)	Interaction	2 (2, 0, 0, 0)
			Dose too high	2 (1, 1, 0, 0)
			Adverse event	1 (1, 0, 0, 0)
			Drug not indicated	1 (1, 0, 0, 0)
			Dose too low	1 (0, 1, 0, 0)
		Antivirals for systemic use (J05)	(Other) incorrect / incomplete patient documentation	1 (0, 1, 0, 0)
L Antineoplastic and immunomodulating agents	7 (2%)	Antineoplastic agents (L01)	Drug not indicated	1 (0, 1, 0, 0)
			Adverse event	1 (0, 1, 0, 0)
		Endocrine therapy (L02)	Adverse event	1 (1, 0, 0, 0)
			Other	1 (1, 0, 0, 0)
			Interaction	1 (0, 1, 0, 0)
		Immunosuppressants (L04)	Adverse event	2 (0, 2, 0, 0)
M Musculo-skeletal system	16 (4%)	Antiinflammatory and antirheumatic products (m01)	Duplication	1 (1, 0, 0, 0)
			Interaction	1 (1, 0, 0, 0)
			Drug not indicated	1 (0, 1, 0, 0)
			Dose too high	1 (0, 0, 1, 0)
		Antigout preparations (M04)	Drug not indicated	3 (0, 3, 0, 0)
			Incomplete patient documentation	2 (1, 1, 0, 0)
			Dose too high	2 (0, 2, 0, 0)
			Dose too low	1 (0, 1, 0, 0)
		Durgs for treatment of bone diseases (M05)	Incomplete patient documentation	2 (0, 2, 0, 0)
			Dose too high	1 (1, 0, 0, 0)
		Other drugs for disorders of the musculo-skeletal system (M09)	Adverse event	1 (1, 0, 0, 0)

N Nervous system	107 (24%)	Analgesics (N02)	Dose too high	14 (10, 2, 1, 1)
			Dose too low	6 (4, 2, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	6 (3, 2, 1, 0)
			Adverse event	5 (3, 1, 1, 0)
			Unsuitable route/form of administration	4 (4, 0, 0, 0)
			Interaction	4 (3, 0, 0, 1)
			Drug not indicated	3 (2, 1, 0, 0)
			Incorrect strength, dosage, frequency, route	2 (2, 0, 0, 0)
		Antiepileptics (N03)	Dose too low	2 (1, 1, 0, 0)
			Dose too high	1 (1, 0, 0, 0)
			Inappropriate/missing monitoring	1 (0, 0, 1, 0)
			Insufficient knowledge of medical staff	1 (0, 1, 0, 0)
			Incomplete patient documentation	1 (0, 1, 0, 0)
		Anti-Parkinson drugs (N04)	Unsuitable route/form of administration	2 (1, 0, 1, 0)
			Interaction	1 (0, 1, 0, 0)
			Drug not recorded in patient documentation	1 (0, 0, 1, 0)
		Psycholeptics (N05)	Drug not indicated	5 (3, 0, 2, 0)
			Interaction	5 (3, 0, 2, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	5 (1, 2, 2, 0)
			Dose too low	4 (2, 2, 0, 0)
			Dose too high	4 (1, 2, 1, 0)
			Incorrect strength, dosage, frequency, route	3 (3, 0, 0, 0)
			Other	2 (2, 0, 0, 0)
			Duplication	2 (2, 0, 0, 0)
			Inappropriate therapy duration	1 (1, 0, 0, 0)
			Adverse event	1 (1, 0, 0, 0)
			Inappropriate/missing monitoring	1 (0, 1, 0, 0)
			Treatment not received	1 (0, 1, 0, 0)
			Prescribed medication unavailable	1 (0, 1, 0, 0)

		Psychoanaleptics (N06)	Interaction	4 (1, 3, 0, 0)
			Drug not indicated	3 (0, 3, 0, 0)
			Dose too low	2 (0, 2, 0, 0)
			Incomplete patient documentation	2 (0, 2, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	1 (1, 0, 0, 0)
			Other	1 (0, 1, 0, 0)
			Incorrect strength, dosage, frequency, route	1 (0, 0, 1, 0)
			Dose too high	1 (0, 1, 0, 0)
			Treatment not received	1 (0, 1, 0, 0)
		Other nervous system drugs (N07)	Other	1 (0, 1, 0, 0)
			Drug not indicated	1 (0, 1, 0, 0)
P Antiparasitic products, insecticide and repellents	3 (1%)	Antiprotozoals (P01)	(Other) incorrect / incomplete patient documentation	1 (0, 1, 0, 0)
R Respiratory system	20 (5%)	Nasal preparations (R01)	Non-conformity with guidelines / potentially inappropriate medication PIM	1 (1, 0, 0, 0)
			Other	1 (1, 0, 0, 0)
		Drugs for obstructive airway diseases (R03)	Unsuitable route/form of administration	5 (3, 1, 1, 0)
			Other	3 (2, 0, 0, 1)
			Insufficient knowledge of the patient	3 (1, 2, 0, 0)
			Non-conformity with guidelines / potentially inappropriate medication PIM	3 (0, 3, 0, 0)
			Drug not indicated	2 (1, 1, 0, 0)
			Treatment not received	1 (1, 0, 0, 0)
		Antihistamines for systemic use (R06)	Drug not indicated	2 (2, 0, 0, 0)
			Dose too high	1 (1, 0, 0, 0)
S Sensory organs	7 (2%)	Ophthalmologicals (S01)	Incomplete patient documentation	4 (1, 3, 0, 0)
			Dose too low	1 (1, 0, 0, 0)
			Other	1 (1, 0, 0, 0)
			Drug not indicated	1 (0, 1, 0, 0)
V Various	2 (1%)	All other therapeutica products (V03)	Dose too high	1 (0, 0, 1, 0)
			Adverse event	1 (0, 0, 0, 1)
			Interaction	1 (0, 0, 0, 1)