Clinical Interventions in Aging

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ORIGINAL RESEARCH

Evaluation of pharmacist interventions and commonly used medications in the geriatric ward of a teaching hospital in Turkey: a retrospective study

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Purpose: Aging increases the prevalence of diseases. The elderly population is consequently often exposed to complex medication regimens. Increased drug use is one of the main reasons for drug-related problems (DRPs). The primary objective of this study was to define and classify DRPs, pharmacist interventions, and frequently prescribed medications in relation to possible DRPs in patients admitted to the geriatric ward of a teaching hospital in Turkey.

Patients and methods: Pharmacist medication review reports for 200 orders of 91 patients (mean age: 80.33±0.46) were analyzed retrospectively.

Results: A total of 1,632 medications were assessed and 329 interventions were proposed for possible DRPs in 156 orders. A total of 87.5% of the patients used five or more drugs (mean: 8.17±0.23). The number of DRPs per order was higher when polypharmacy was present (1.04±0.15 vs 1.66±0.11, $P<0.05$). In 71.31% of the cases, adverse drug events were recognized as the problem. The principal cause of possible DRPs was determined as drug interactions (40.12%). Only 22 potentially inappropriate medications were prescribed. The most common interventions included monitoring drug therapy (31.0%), stopping the drug (20.06%), and changing dosage (13.98%). The acceptance rate of pharmacist interventions by treating geriatrician was 85.41%. The most frequently prescribed drugs were for the nervous system, alimentary tract and metabolism, and cardiovascular system (n=358, 314, and 304, respectively). The pharmaceutical forms of 23 drugs were deemed inappropriate by pharmacists.

Conclusion: Clinical pharmacy services are still not properly implemented in Turkey. The study highlights ways in which clinical pharmacy services can be instrumental in a geriatric ward. The high acceptance rates of pharmacist recommendations concerning a wide variety of DRPs and different classes of drugs indicate that advanced collaboration among geriatricians and pharmacists is possible in interdisciplinary geriatric assessment teams in Turkey.

Keywords: pharmaceutical care, clinical pharmacy, elderly, medication review, polypharmacy, potentially inappropriate medication

Introduction

According to the United Nations' World Population Prospects report, population aging is occurring throughout the world and the number of older persons in the world is projected to be 2.1 billion in 2050. In Turkey, life expectancy at birth is estimated to be 82.5 and 89.1 years by the end of 2050 and 2100, respectively.[1] With aging, the prevalence of diseases and geriatric syndromes increases; as a consequence, the elderly population is more frequently exposed to complex medication regimens and

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increased drug use.[2–5] Polypharmacy increases the risk of drug-related problems (DRPs), potentially inappropriate use of medications (PIMs), and hospitalizations, all of which are common among elderly people.[2,3,6,7]

A DRP is defined as "an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes".[8] In addition to clinical impact, DRPs also increase health expenditure, which causes economic burden.[9,10] Several studies have found that pharmacists provide added value in resolving and preventing DRPs in settings such as outpatient clinics, acute care in inpatients, nursing homes, and palliative care.[5,11–18] Studies from inpatient settings have also shown that including a pharmacist as a member of the interdisciplinary health care team may improve outcomes and decrease drug-related readmissions and mortality in geriatric patients.[2,17,19–21] As team members, pharmacists offer an additional perspective in the application of medication reviews, resulting in an increase in detection of DRPs and a reduction of polypharmacy in elderly inpatients.[21]

Pharmaceutical care, described as the pharmacist's contribution to the care of individuals in order to optimize medicines use and improve health outcomes, is the foundation of clinical pharmacy. In the past decade, changes in pharmacy undergraduate education and new legislations in the Turkish health care system have indicated increasing recognition of the pharmaceutical care practice. However, the provision of clinical pharmacy services is still a fairly new concept. Therefore, the need to establish basic standard operating procedures for ward-based pharmacy services and improving efficiently delivered quality of care has emerged. The primary objective of this study was to define and classify the DRPs and pharmacist interventions in the geriatric ward of a teaching hospital in Turkey. The paper's secondary objective was to determine frequently prescribed medications and pharmaceutical forms in relation to possible DRPs in the study population.

Patients and methods

Settings and data collection

The study was conducted between December 2017 and July 2018 in the acute geriatric ward (10 beds) of a government-run 1,800-bed tertiary university hospital in Turkey. Patients aged 65 or over admitted to the outpatient geriatric clinic or emergency department of the same hospital with typical acute geriatric problems were hospitalized. Referrals from other smaller district hospitals (primary or secondary care) were also accepted. Patients were cared for by an interdisciplinary team of geriatricians, nurses, and dieticians. Medical care and discharge planning were provided.

Two licensed pharmacists working at the Department of Clinical Pharmacy, Faculty of Pharmacy at the Ege University began to participate in the weekly interdisciplinary geriatric rounds in December 2017, and a medication review service is provided routinely once a week thereafter. Pharmacists reviewed medication orders, medication history, and/or clinical data (such as vitals and biochemical markers) in the medication review process to detect possible DRPs and prepare a report of possible DRPs and interventions for each order 1 day before weekly interdisciplinary rounds. The reports were discussed and reviewed with a geriatrician during the weekly interdisciplinary rounds. The acceptance status of the proposals was then noted by pharmacists.

In the medication review process, the latest medication orders of patients were evaluated for DRPs by software-based, guideline-based, or knowledge-based approach by the pharmacist. Drug–drug, food–drug, and disease–drug interactions and intravenous incompatibilities were analyzed with RxMediaPharma® Interactive Drug Database.[22] PIM or potentially inadequate medication use in geriatric patients was determined using Beers criteria,[23] Screening Tool of Older Persons' potentially inappropriate Prescriptions (STOPP) criteria, and Screening Tool to Alert doctors to the Right Treatment (START) criteria.[24] The latest clinical practice guidelines for specific diseases were used to support clinical decisions when necessary.

Data analysis

The pharmacist reports for 200 medication orders of 91 patients were examined retrospectively. Problem type, cause of problem, proposed intervention, and acceptance status for the proposed interventions were classified according to Pharmaceutical Care Network Europe's (PCNE) definitions and DRP classifications (the PCNE Classification V 8.02).[8] As using standard terms would facilitate the comparison of the results of studies, PCNE recommends the utilization of standard pharmaceutical care terms in European countries.[8,25,26] Detailed classification of data is shown in Table S1 with subcategories and frequencies. One DRP may have more than one cause and may lead to the proposition of more than one intervention.

Definitions

A problem is defined as "the expected or unexpected event or circumstance that is, or might be wrong, in therapy with drugs".[8] As per definition, both manifest and possible

problems are included in this study. Problems of a technical nature (logistic, computer error, etc.) are specified accordingly.

The cause is defined as "the action (or lack of action) that leads up to the occurrence of a potential or real problem".[8]

The intervention is the proposed measures to be taken to overcome the cause of the problem by the pharmacist to prevent or solve a problem. The proposed course of action is deemed to improve and/or maintain patients' health and well-being.

Acceptance is defined as the acceptance status of the pharmacist intervention proposals evaluated by physicians.

Statistical analysis

The normality of the data was analyzed using the Kolmogorov–Smirnov test. Continuous data were described by mean ± standard error of mean. Categorical data were described in terms of frequencies. Correlation between the number of DRPs and total medications per order was assessed using Pearson's correlation test. The number of DRPs in orders according to age and gender and the absence or presence of renal impairment and polypharmacy were analyzed using Student's *t*-test. Data were analyzed using SPSS version 25.0 (IBM SPSS Statistics for Windows, Version 25.0; IBM Corp., Armonk, NY, USA). A *P*-value ≤0.05 was considered significant.

Ethical considerations

This study was approved by the Ethics Committee for Clinical Research of Faculty of Medicine at Ege University (Date: October 2, 2018; No: 18-10/4). All patients or their substitute decision maker gave written informed consent for their participation.

Results

The pharmacists' reports for 200 medication orders of 91 patients were analyzed. A total of 55 of these patients were admitted to the hospital for two to six consecutive weeks, and seven patients were readmitted two to three times within 6 months after discharge. Characteristics of the patients are presented in Table 1.

Pharmacists detected 329 possible DRPs in 156 orders and no problem was detected in 44 orders. The PCNE categories of possible DRPs and their frequencies are shown in Figure 1. The number of medications and DRPs per order was not different across different age groups, genders, or in the absence or presence of renal impairment (Table 1). There was a significant weak positive correlation between the number of total drugs used and the number of DRPs per order ($P<0.05$, $r=0.2819$; Pearson's correlation test). Polypharmacy, described as using five or more drugs, was present in 175 (87.5%) orders. The number of DRPs was higher when polypharmacy was present ($P<0.05$; Table 1).

Table 1 Characteristics of patients, number of medications, and DRPs

	Medication (mean ± SEM)	DRP (mean ± SEM)
Patient's age (n=200; 80.33±0.46)	8.17±0.23	1.58±0.098
65–79 years (n=78)	7.95±0.33	1.59±0.15
≥80 years (n=122)	8.32±0.31	1.58±0.13
Patient's gender		
Male (n=69)	7.65±0.35	1.41±0.14
Female (n=131)	8.45±0.29	1.68±0.13
Renal function		
eGFR >60 mL/min/1.73 m^2 (n=84)	8.45±0.36	1.42±0.13
eGFR ≤60 mL/min/1.73 m^2 (n=83)	8.13±0.36	1.76±0.17
Unknown[a] (n=33)	7.58±0.44	1.58±0.23
Number of medication per order		
0–4 (n=25)	3.40±0.20	1.04±0.15
≥5 (n=175)	8.86±0.21	1.66±0.11[b]

Notes: [a]Unknown at the time of medication review due to new admission of the patient and/or biochemistry results being incomplete at the time of interdisciplinary round. [b]$P\leq0.05$; Student's *t*-test (number of medications per order; 0–4 vs ≥5).
Abbreviations: DRPs, drug-related problems; eGFR, estimated glomerular filtration rate; SEM, standard error of mean.

One DRP may have had more than one cause that led to the recommendation of more than one intervention. A complete list of combinations of causes and interventions for each DRP is presented in Table S1. In brief, most causes of possible DRPs were drug interactions (including IV incompatibilities), inadequate monitoring, and a high drug dose (Table 2).

A total of 329 interventions were proposed and/or discussed by pharmacists – 282 (85.71%) of these interventions were proposed to the prescribers, and on 47 (14.28%) occasions, the prescriber was only informed, or the intervention was discussed with the prescriber. The most frequently recommended intervention was monitoring, which was followed by stopping the drug and changing dosage or instructions for use (Figure 2). A full list of PCNE categories of the interventions is presented in Table S1. The acceptance rate of pharmacist interventions was 85.41% (n=281). Intervention was accepted and fully implemented in 223 cases (67.78%), partially implemented in 40 cases (12.16%),

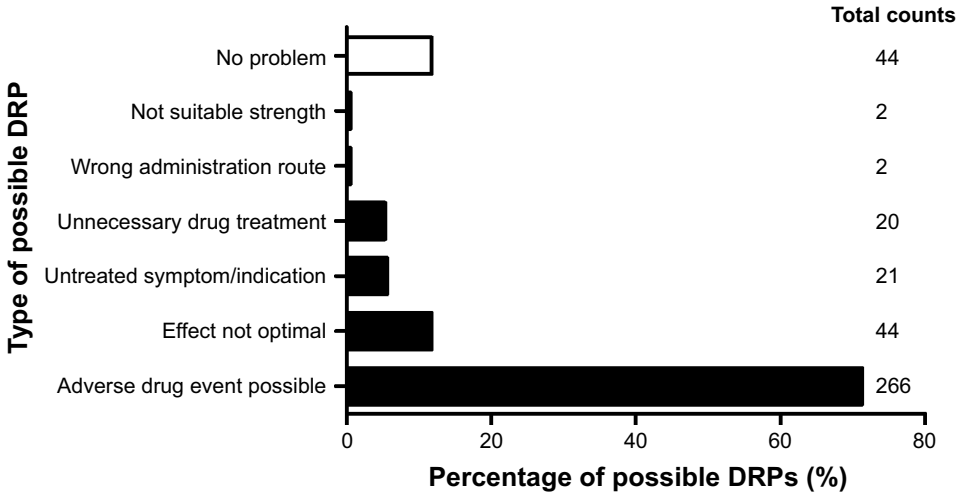

Figure 1 PCNE categories of possible drug-related problems and their frequencies.
Abbreviations: PCNE, Pharmaceutical Care Network Europe; DRPs, drug-related problems.

not implemented in 12 cases (3.65%), and implementation status was not known in 6 cases (1.82%). Only 38 (11.55%) of the proposed interventions were rejected by the physician due to being not feasible (n=19, 5.78%), unknown reasons (n=1, 0.3%), and other reasons (n=18, 5.47%), such as the patient being closely monitored, prior recommendations of another specialist (psychiatry/infectious disease/cardiology), or patient record error in hospital information system leading to misinformation but patient receiving the correct drug form/dosage. The acceptance status of ten intervention proposals (3.04%) was unknown due to the physician not making the decision during rounds and referring the patient to other physicians for further consultations. In one case, written information was provided only to the physician. On account of this study being performed in a teaching hospital, medical students also participated in the routine rounds. Pharmacist intervention proposals led to educational discussions on six different cases and were noted as separate interventions. Detailed acceptance rates with respect to intervention category are presented in Figure 2.

During this study, 1,632 medications were ordered. Medications were coded following the WHO–Anatomical Therapeutic Chemical (WHO–ATC) classification. ATC groups of the most ordered drugs were N (nervous system, 358), A (alimentary tract and metabolism, 314), C (cardiovascular system, 304), B (blood and blood-forming organs, 197), and J (anti-infectives for systemic use, 151) (Table 3). The number of possible DRPs for each prescribed drug in the geriatric ward was analyzed, and the ten medications with overall highest DRP counts and the medications with the highest DRP counts in each ATC class were determined (Table 3).

Pantoprazole, enteral nutrition products, enoxaparin, furosemide, metoprolol, sertraline, quetiapine, insulin glargine,

Table 2 PCNE categories of most encountered causes of possible DRPs and their frequencies

PCNE code	PCNE category	Total counts (n, %)
C 1.4	Inappropriate combination of drugs or drugs and herbal medication (includes intravenous incompatibility)	132 (40.12%)
C 8.1	No or inappropriate outcome monitoring	47 (14.29%)
C 3.2	Drug dose too high	41 (12.46%)
C 1.2	Inappropriate drug (within guidelines but otherwise contraindicated)	30 (9.12%)
C 8.2.1	Patient education required	28 (8.51%)
C 6.6	Drug administered via wrong route	27 (8.21%)
C 1.6	No drug treatment in spite of existing indication	23 (6.99%)
C 2.1	Inappropriate drug form (for this patient)	23 (6.99%)
C 1.1	Inappropriate drug according to guidelines/formulary	22 (6.69%)

Abbreviations: PCNE, Pharmaceutical Care Network Europe; DRPs, drug-related problems.

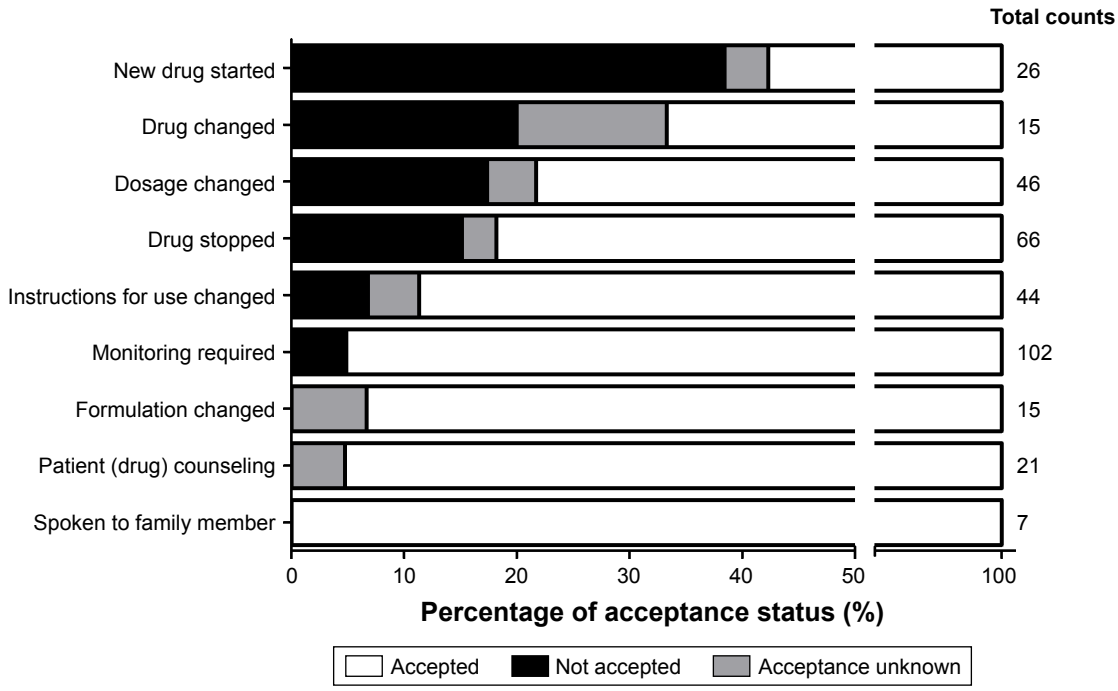

Figure 2 PCNE categories of interventions proposed by the pharmacist and their acceptance rates.
Abbreviation: PCNE, Pharmaceutical Care Network Europe.

Table 3 Total number of ordered medications, most frequently ordered medications, and medications with the highest number of possible DRPs in each ATC class

ATC class	Number of ordered medications	Most frequently ordered medication (n, % in related ATC group)	Medications with highest DRP (possible) counts (n, % in related ATC group)
A	314	Pantoprazole (107, 34.08%)	**Pantoprazole (19, 6.05%)**
B	197	Enoxaparin (60, 30.46%)	**Enoxaparin (15, 4.93%)**
C	304	Furosemide (57, 18.75%)	**Furosemide (15, 7.61%)** **Metoprolol (12, 6.09%)**
D	34	Silver sulfadiazine (10, 29.41%)	–
G	44	Tamsulosin (19, 43.18%)	Silodosin (3, 6.82%)
H	53	Levothyroxine (20, 37.74%)	**Methylprednisolone (13, 24.53%)**
J	151	Ceftriaxone (26, 17.22%)	Ciprofloxacin (11, 7.28%)
L	10	Methotrexate (2, 20.00%)	Mycophenolate (3, 30.00%)
M	11	Allopurinol (3, 27.27%)	Allopurinol (2, 18.18%) Colchicine (2, 18.18%)
N	358	Sertraline (45, 12.57%)	**Quetiapine (41, 11.45%)** **Donepezil (27, 7.54%)** **Sertraline (19, 5.31%)** **Escitalopram (12, 3.35%)**
P	2	Metronidazole (2, 100.00%)	Metronidazole (1, 50.00%)
R	65	Salbutamol + Ipratropium (26, 40.00%)	**Salbutamol + Ipratropium (11, 16.92%)**
S	11	Brimonidine + Timolol (4, 36.36%)	–
V	78	Enteral nutrition (61, 78.21%)	Enteral nutrition (6, 7.69%)
Total	1,632		

Note: Boldface medications are the 10 medications with overall highest possible DRP counts.
Abbreviations: DRPs, drug-related problems; ATC, Anatomical Therapeutic Chemical.

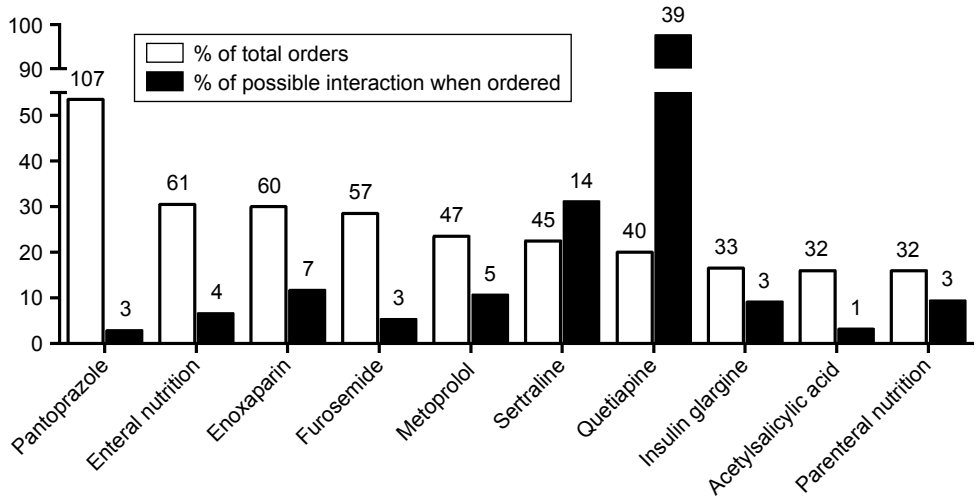

Figure 3 Most frequently ordered medications and possible interaction or incompatibility risk in function of their prescription frequency. (Numbers above each bar represent total counts.)

acetylsalicylic acid (ASA), and parenteral nutrition were the most frequently prescribed medications in 200 orders among elderly patients (Figure 3). Possible drug–drug, drug–herbal medication, food–drug interactions, and intravenous incompatibilities related to these medications were represented as a percentage of possible clinically significant interactions encountered per total number of times prescribed (Figure 3).

Only 22 PIMs, according to the Beers criteria, STOPP/START criteria, or latest clinical practice guidelines were prescribed during the study period. PIMs ordered on more than one occasion were ipratropium, lorazepam, haloperidol, ASA, and dimenhydrinate (prescribed 3, 2, 2, 2, and 2 times, respectively). Adverse events were deemed possible in 20 of these cases, 10 of which were due to inappropriate combinations of drugs and excessively high dosages. On two occasions, medication was regarded unnecessary by the pharmacist. Intervention proposals to stop or change drugs, monitor effects, or educate patients were accepted in 19 (86.36%) occasions (Table S1).

The appropriateness of the drug formulation for each patient was also evaluated and coded following NFC (EphMRA [The European Pharmaceutical Market Research Association] New Form Code) classification. Only 23 drug formulations were interpreted as inappropriate by pharmacists. For the most part, swallowing difficulties among patients or crushing or splitting of oral solid ordinary film-coated tablets (ABC, n=15), oral solid retard film-coated tablets (BBC, n=3), oral solid ordinary enteric-coated tablets (ABD, n=2), and oral solid retard tablets (BAA, n=2) caused the problem. Finally, as intramuscular injection is not a favorable route of administration in the elderly, prescription of a parenteral ordinary IM ampoule (FMD) instead of an oral pharmaceutical form led to intervention in one order. However, on 14 of these occasions, suitable drug formulation was not available in the hospital pharmacy, and three occasions resulted from an error in the hospital information system, and the patient was administered the correct form of the drug.

Discussion

This study found that pharmacists contribute to health care provisions, as members of interdisciplinary geriatric teams in Turkey, by proposing a large number of accepted interventions to a wide variety of DRPs, different classes, and pharmaceutical forms of drugs.

Aging is associated with an increase in medication use parallel to the increase in chronic diseases and geriatric syndromes.[3,7,27] Based on this paper's findings, patients' orders consisted of an average of 8.17 medications. This paper supports previous studies reporting an average of 7.2–9 medications taken by patients daily.[17,19,28,29] A slightly high number (mean 11.4 drugs) was reported in a study in Belgium.[20]

While pharmacotherapy contributes to a patient's general state of well-being, all medications also have a risk of adverse or unwanted effects. Although the number of prescribed drugs or possible DRPs was not different in patients with renal impairment, pharmacists must focus on drug doses as both aging and poor renal functions may alter drug metabolism leading to untoward consequences and interactions. The number of DRPs was not different in older patients (65–79 years vs ≥80 years) in our study, which matches the previous findings that age does not have a direct effect on

adverse drug events (ADEs).[30] It is widely accepted that the higher the number of drugs, the higher the number of DRPs, and polypharmacy is a known risk factor in the development of DRPs.[2,3,6,7] In accordance, this study found a positive correlation between the number of medications and DRPs. Polypharmacy was present in most of the orders (87.5%), and the DRP count was higher in the presence of polypharmacy.

DRPs have a significant impact on health, and ADEs are an important component of DRPs. It is estimated that, one in every ten elderly patients experience ADEs during or leading to their hospital stay.[31] In our study, in 71% of the cases, ADE possibility was recognized as a problem. The main cause of this possible problem was determined as drug interactions (44.4%). This study's results indicate that geriatric patients' orders must be reviewed by focusing on drug interactions. Regardless of the problem type, drug interactions were also the leading cause of problems (40.1%) in all DRPs. Clinically significant interactions were the main factor in pharmacist interventions in a geriatric day unit and orthogeriatric wards in another study with relative compatibility to our results (21.1% and 30.4% of the interventions, respectively).[2] In another study conducted in Turkey, inappropriate combination of drugs was accounted as the reason for 29.5% of the overall DRPs in the general internal medicine ward.[11]

A total of 329 interventions were recommended by the pharmacist, and 85.4% of these interventions were accepted by the treating physician in this study. Comparable acceptance rates were reported in a study focused on the implementation of ward-based pharmacy services in Belgium.[17] The high acceptance rates indicate that, although clinical pharmacy is a new concept in Turkey, the physicians in the geriatric ward of the hospital is open to collaboration with pharmacists. The most common interventions were monitoring drug therapy (monitoring ECG, serum electrolytes, bleeding risk, vitals, anticholinergic side effects; 31%), stopping drug use (20.1%), and changing dosage (14%) or instructions for use (13.4%) in this study. Interestingly, the most common interventions were cessation or dose alteration of drugs in three studies, where an average of 9.6–11.5 medications was used,[15,20,32] and monitoring drug therapy was the second most prevalent intervention in one of them.[15] Taken these results into account, it may be assumed that, when the number of drugs used by patients increases, pharmacists' and geriatricians' efforts to simplify patients' therapy outweigh the need for monitoring.

According to the ATC classification system, drugs affecting the nervous system (N), alimentary tract and metabolism (A), cardiovascular system (C), and blood and blood-forming organs (B) were the most frequently ordered drugs. In a study from Brazil, N-, A-, and C-class drugs were mostly prescribed for patients above 60 years.[33] Likewise, Recoche et al[34] and Somers et al[20] reported that C-, N-, A-, and B-class drugs were the most frequently prescribed drugs for frail elderly inpatients. Pantoprazole was the most frequently ordered medication in this study (53.5% of total orders). The reason for this high rate may be due to concurrent enoxaparin, ASA, or sertraline use (30%, 16%, and 22.5% of total orders) and the presence of conditions that can increase the risk of bleeding. Accordingly, monitoring bleeding risk was proposed by the pharmacist as an intervention when the medications were prescribed.

Delirium incidences increase in patients over 65 years, and in selected patients, haloperidol or second-generation antipsychotics can be used to reduce agitation and hyperactivity.[35,36] In this study, quetiapine was ranked first among medications with the highest possible DRP count among nervous system drugs and was also found to almost always (97.5%) cause possible drug interactions when prescribed. As polypharmacy is a factor known to increase mortality in patients with delirium,[36] pharmacists should control quetiapine orders for interactions and other DRPs. Depression is common in older individuals and selective serotonin reuptake inhibitors (SSRIs) are prescribed as first-line treatment, though drug interactions are common in patients with polypharmacy.[37] Consistent with this finding, sertraline was the overall sixth most prescribed drug in this study. This drug was also among medications with the highest possible DRP count and deemed to cause possible drug interaction 31% of the times that it was prescribed. This paper recommends that particular attention be paid to the prescription of SSRIs in elderly patients when polypharmacy is present. The most noted interaction with either quetiapine or sertraline was the possibility of QTc prolongation in this study. The categories of intervention recommendations (monitoring serum electrolytes and ECG, or stopping or reducing the dosage of the drug) were similar to those of another study investigating drug-induced QT prolongation.[38] Therefore, this paper suggests that pharmacists perform a thorough medication review and recommends monitoring ECG in patients using drugs with known risk of QT interval prolongation taking additional risk factors such as advanced age, gender, and electrolyte derangements into consideration in elderly population.[38]

Potentially inappropriate prescribing is highly prevalent among geriatric patients.[3] Di Giorgio et al[39] reported

that 49% and 27% of the geriatric patients had at least one PIM during hospitalization period according to Beers and STOPP criteria, respectively. In a study from Turkey, PIMs were found in 19.5% of elderly patients admitted to internal medicine ward.[19] Conversely, only 22 PIMs were present in 21 orders (10.5%) in this study. The reason for this low prevalence may be due to patients' treatment being undertaken by geriatric specialists. Indeed, a study reported that patients discharged from geriatric wards were found to have lower prevalence of PIMs compared to those discharged from an internal medicine ward.[28] The acceptance rates of intervention recommendations for resolving PIMs (patient counseling, dosage change, monitoring therapy, and stopping drug) were high (86.36%) in this study. Pharmacists in Turkey should ensure that their knowledge is up-to-date and follow current guidelines to ensure that they make accurate and valid contributions to geriatric patient care as members of the interdisciplinary team.

Swallowing difficulties have particular importance in clinical pharmacy practice as oral solid pharmaceutical forms are usually needed to be split or crushed. As a result, the pharmacokinetics and stability of these drugs may alter causing ADEs or undertreatment. The need for giving the drugs via nasogastric tube is further complicated, as drugs can cause clogging of the feeding tube or drug-enteral nutrition interactions.[40] According to this study's results, only 23 drug formulations' pharmaceutical form was deemed inappropriate by pharmacists. Swallowing difficulties and the need for dosage reduction resulted in crushing or splitting of oral solid ordinary/retard film-/enteric-coated tablets and oral solid retard tablets in 22 cases. Recommended pharmaceutical form change could not be accepted in 14 of these cases because the suitable form was not available in the hospital formulary. This paper suggests that hospital pharmacists' awareness of this geriatric syndrome should be extended in Turkey. Considering the needs of special populations, more than one choice of pharmaceutical form (oral liquid, oral immediate release, or patch formulations) for each highly prescribed active ingredient should be made available to hospital pharmacies.

Finally, making comparisons with other studies was difficult, mainly because most of the previous studies did not report DRPs, their causes, or recommended intervention categories in accordance with standardized classification systems. This study supports the use of the PCNE classification systems for documenting clinical pharmacy activities, both for standard record keeping and facilitating scientific data sharing and comparison across Turkey and Europe.

Limitations

In this study, pharmacist interventions were evaluated retrospectively. The pharmacists assessed and defined the DRPs prior to ward rounds. Therefore, DRPs were not classified as possible or actual (manifest) problems. Although the acceptance status of the recommended interventions was recorded, the outcomes were not determined with follow-up evaluations due to time and resource restrictions. As participation of pharmacists in geriatric assessment teams is a fairly new practice in Turkey, this study was conducted in one hospital. This setting resulted in a relatively small sample size and may be considered another limitation of the study. Based on this study's findings, it may be more beneficial to reassess frequently encountered DRPs and associated drugs in subgroups of patients with the outcome analysis of pharmacist interventions.

Conclusion

The present study highlights the ways in which clinical pharmacy services can be instrumental in a geriatric ward. Pharmacists must be vigilant about ADEs and drug interactions as these issues are the most frequently encountered problems and the most common causes of problems, respectively. This study found that pharmacists may need to suggest monitoring drug therapy, stopping drugs, and changing dosages or instructions for use frequently. Raising awareness of the lack of available pharmaceutical form choices for highly prescribed medications in hospital formularies can reduce the problems associated with splitting or crushing of oral solid pharmaceutical forms. Polypharmacy, alterations in pharmacokinetics and pharmacodynamics of drugs, is largely unavoidable in many geriatric inpatients. The participation of pharmacists in geriatric assessment teams can assist geriatric specialists in rational therapeutic decision-making and improving care quality. The findings of this study suggest that advanced collaboration among geriatricians and pharmacists as well as other health care professionals is possible and preferable in an interdisciplinary geriatric team in Turkey. Pharmacists' recommendations on a wide variety of DRPs and different classes and pharmaceutical forms of drugs have been accepted by physicians. The results may also be used to extrapolate and construct a feasible standard operating model that defines both the role of the pharmacist and the pharmacist's relationship with other health care professionals, leading to the effective use of resources in the Turkish health care system.

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Disclosure

The authors report no conflicts of interest in this work.

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Supplementary material

Table S1 Types and causes of problems, proposed interventions, and acceptance status for proposed interventions

Cause	Intervention	Acceptance
Problem: none (n=44)		
Problem: effect of drug treatment not optimal (n=20)		
Inappropriate combination of drugs* (n=6)	Drug changed (n=1)	Fully accepted (n=1)
	Dosage changed (n=1)	Accepted; implementation unknown (n=1)
	Monitoring required (n=4)	Fully accepted (n=2)
		Not accepted: not feasible (n=1)
		Not accepted: other (n=1)
Inappropriate combination of drugs* + inappropriate timing of administration and/or dosing intervals (n=2)	Instructions for use changed (n=2)	Fully accepted (n=1)
		Partially accepted (n=1)
Inappropriate combination of drugs* + patient education required (n=5)	Patient (drug) counseling (n=1)	Fully accepted (n=1)
	Patient (drug) counseling + instructions for use changed (n=3)	Fully accepted (n=3)
	Spoken to family member/caregiver (n=1)	Fully accepted (n=1)
Inappropriate drug form (n=1)	Drug changed (n=1)	Fully accepted (n=1)
Drug dose too low (n=1)	Dosage changed (n=1)	Fully accepted (n=1)
Drug dose too low + patient education required (n=1)	Patient (drug) counseling (n=1)	Fully accepted (n=1)
Dosage regimen not frequent enough (n=1)	Educational discussion started during routine rounds (n=1)	Fully accepted (n=1)
Wrong drug administered (n=1)	Drug changed (n=1)	Partially accepted (n=1)
Patient stores drug inappropriately + patient education required (n=1)	Patient (drug) counseling (n=1)	Fully accepted (n=1)
Addition of new drug might be needed due to microbial resistance (n=1)	New drug started (n=1)	Fully accepted (n=1)
Problem: effect of drug treatment not optimal + adverse drug event (possibly) occurring (n=24)		
Inappropriate combination of drugs* (n=2)	Monitoring required (n=1)	Partially accepted (n=1)
	Drug stopped (n=1)	Partially accepted (n=1)
Drug administered via wrong route (n=22)	Instructions for use changed (n=22)	Fully accepted (n=22)
Problem: untreated symptoms or indication (n=20)		
No drug treatment in spite of existing indication (n=20)	New drug started (n=20)	Fully accepted (n=9)
		Partially accepted (n=2)
		Not accepted: not feasible (n=5)
		Not accepted: other (n=4)
Problem: untreated symptoms or indication + adverse drug event (possibly) occurring (n=1)		
Inappropriate combination of drugs* + no drug treatment in spite of existing indication (n=1)	New drug started (n=1)	Partially accepted (n=1)
Problem: adverse drug event (possibly) occurring (n=240)		
Inappropriate drug according to guidelines/formulary (n=10)	Drug stopped (n=10)	Fully accepted (n=4)
		Partially accepted (n=2)
		Accepted; not implemented (n=1)
		Not accepted: other (n=2)
		Acceptance status unknown (n=1)

(*Continued*)

Table S1 (*Continued*)

Cause	Intervention	Acceptance
Inappropriate drug according to guidelines/ formulary + inappropriate combination of drugs (n=5)	Drug stopped (n=2)	Partially accepted (n=2)
	Drug stopped + monitoring required (n=2)	Fully accepted (n=1)
		Partially accepted (n=1)
	Monitoring required (n=1)	Fully accepted (n=1)
Inappropriate drug according to guidelines/formulary + drug dose too high (n=5)	Dosage changed (n=2)	Partially accepted (n=2)
	Drug stopped (n=2)	Fully accepted (n=1)
		Partially accepted (n=1)
	Monitoring required (n=1)	Fully accepted (n=1)
Inappropriate drug (within guidelines but otherwise contraindicated) (n=23)	Drug changed (n=2)	Fully accepted (n=1)
		Acceptance status unknown (n=1)
	Dosage changed (n=6)	Fully accepted (n=2)
		Not accepted: not feasible (n=4)
	Instructions for use changed (n=2)	Fully accepted (n=2)
	Drug stopped (n=10)	Fully accepted (n=4)
		Partially accepted (n=2)
		Not accepted: not feasible (n=2)
		Not accepted: other (n=1)
		Acceptance status unknown (n=1)
	Monitoring required (n=3)	Fully accepted (n=3)
Inappropriate drug (within guidelines but otherwise contraindicated) + drug dose too high (n=4)	Dosage changed (n=3)	Fully accepted (n=3)
	Drug stopped (n=1)	Partially accepted (n=1)
Inappropriate drug (within guidelines but otherwise contraindicated) + drug dose too high + no or inappropriate outcome monitoring (n=1)	Dosage changed + monitoring required (n=1)	Fully accepted (n=1)
Inappropriate drug (within guidelines but otherwise contraindicated) + dosage regimen too frequent (n=1)	Drug stopped (n=1)	Fully accepted (n=1)
Inappropriate drug (within guidelines but otherwise contraindicated) + no or inappropriate outcome monitoring (n=1)	Monitoring required (n=1)	Fully accepted (n=1)
Inappropriate combination of drugs* (n=67)	Written information provided only (n=1)	Fully accepted (n=1)
	Drug changed (n=4)	Fully accepted (n=1)
		Partially accepted (n=1)
		Not accepted: not feasible (n=1)
		Acceptance status unknown (n=1)
	Drug changed + monitoring required (n=2)	Partially accepted (n=1)
		Not accepted: not feasible (n=1)
	Dosage changed (n=3)	Fully accepted (n=2)
		Not accepted: other (n=1)
	Instructions for use changed (n=2)	Fully accepted (n=1)
		Not accepted: not feasible (n=1)
	Drug stopped (n=11)	Fully accepted (n=3)
		Partially accepted (n=5)
		Not accepted: not feasible (n=1)
		Not accepted: other (n=2)
	Monitoring required (n=44)	Fully accepted (n=42)
		Not accepted: other (n=1)
		Not accepted: unknown reason (n=1)

(*Continued*)

Table S1 (*Continued*)

Cause	Intervention	Acceptance
Inappropriate combination of drugs* + too many drugs prescribed for indication (n=1)	Drug stopped + monitoring required (n=1)	Partially accepted (n=1)
Inappropriate combination of drugs* + too many drugs prescribed for indication + no or inappropriate outcome monitoring (n=2)	Drug stopped + monitoring required (n=1)	Partially accepted (n=1)
	Monitoring required (n=1)	Fully accepted (n=1)
Inappropriate combination of drugs* + drug dose too high (n=1)	Dosage changed (n=1)	Fully accepted (n=1)
Inappropriate combination of drugs* + no or inappropriate outcome monitoring (n=27)	Drug changed + monitoring required (n=1)	Fully accepted (n=1)
	Drug stopped + monitoring required (n=5)	Fully accepted (n=2)
		Partially accepted (n=3)
	Monitoring required (n=21)	Fully accepted (n=21)
Inappropriate combination of drugs* + patient education required (n=11)	Patient (drug) counseling (n=6)	Fully accepted (n=4)
		Accepted; implementation unknown (n=1)
		Acceptance status unknown (n=1)
	Spoken to family member/caregiver (n=5)	Fully accepted (n=5)
Inappropriate duplication of therapeutic group or active ingredient (n=1)	Drug stopped (n=1)	Not accepted: not feasible (n=1)
Inappropriate duplication of therapeutic group or active ingredient + too many drugs prescribed for indication (n=1)	Drug stopped (n=1)	Partially accepted (n=1)
Inappropriate duplication of therapeutic group or active ingredient + drug dose too high (n=1)	Drug stopped (n=1)	Fully accepted (n=1)
No drug treatment in spite of existing indication (n=2)	New drug started (n=2)	Fully accepted (n=1)
		Not accepted: not feasible (n=1)
Inappropriate drug form (n=19)	Drug changed (n=2)	Fully accepted (n=1)
		Not accepted: other (n=1)
	Formulation changed (n=13)	Fully accepted (n=1)
		Partially accepted (n=1)
		Accepted; not implemented (n=7)
		Accepted; implementation unknown (n=3)
		Acceptance status unknown (n=1)
	Instructions for use changed (n=4)	Fully accepted (n=2)
		Not accepted: not feasible (n=1)
		Acceptance status unknown (n=1)
Inappropriate drug form + prescribed drug not available (n=1)	Instructions for use changed (n=1)	Accepted; not implemented (n=1)
Drug dose too low (n=2)	Dosage changed (n=1)	Fully accepted (n=1)
	Dosage changed + new drug started (n=1)	Acceptance status unknown (n=1)
Drug dose too high (n=26)	Dosage changed (n=22)	Fully accepted (n=14)
		Partially accepted (n=6)
		Not accepted: other (n=1)
		Acceptance status unknown (n=1)
	Instructions for use changed (n=1)	Fully accepted (n=1)
	New drug started (n=1)	Fully accepted (n=1)
	Monitoring required (n=2)	Fully accepted (n=2)
Drug dose too high + no or inappropriate outcome monitoring (n=1)	Drug stopped + monitoring required (n=1)	Fully accepted (n=1)

(*Continued*)

Table S1 (*Continued*)

Cause	Intervention	Acceptance
Dosage regimen too frequent (n=3)	Dosage changed (n=2)	Not accepted: other (n=2)
	Instructions for use changed (n=1)	Fully accepted (n=1)
Dose timing instructions wrong, unclear or missing + no or inappropriate outcome monitoring (n=1)	Monitoring required (n=1)	Partially accepted (n=1)
Drug administered via wrong route (n=3)	Instructions for use changed (n=3)	Fully accepted (n=2)
		Acceptance status unknown (n=1)
Patient uses/takes less drug than prescribed or does not take the drug at all + patient education required (n=2)	Patient (drug) counseling (n=1)	Fully accepted (n=1)
	Spoken to family member/caregiver (n=1)	Fully accepted (n=1)
Patient takes food that interacts + patient unable to use drug/form as directed + patient education required (n=1)	Patient (drug) counseling (n=1)	Fully accepted (n=1)
No or inappropriate outcome monitoring (n=11)	Drug changed (n=1)	Partially accepted (n=1)
	Educational discussion started during routine rounds (n=5)	Fully accepted (n=5)
	Monitoring required (n=5)	Fully accepted (n=5)
No or inappropriate outcome monitoring + patient education required (n=2)	Patient (drug) counseling (n=1)	Fully accepted (n=1)
	Patient (drug) counseling + monitoring required (n=1)	Fully accepted (n=1)
Patient education required (n=4)	Patient (drug) counseling (n=4)	Fully accepted (n=4)
Problem: adverse drug event (possibly) occurring + unnecessary drug-treatment (n=1)		
Inappropriate combination of drugs* (n=1)	Drug stopped (n=1)	Fully accepted (n=1)
Problem: unnecessary drug treatment (n=19)		
Inappropriate drug according to guidelines/formulary + inappropriate combination of drugs* (n=1)	Drug stopped (n=1)	Fully accepted (n=1)
Inappropriate drug according to guidelines/formulary + patient education required (n=1)	Patient (drug) counseling + drug stopped (n=1)	Fully accepted (n=1)
No indication for drug (n=3)	Drug stopped (n=3)	Fully accepted (n=3)
Inappropriate duplication of therapeutic group or active ingredient (n=6)	Instructions for use changed (n=1)	Not accepted: other (n=1)
	Drug stopped (n=5)	Fully accepted (n=3)
		Accepted; implementation unknown (n=1)
		Not accepted: other (n=1)
Too many drugs prescribed for indication (n=4)	Drug stopped (n=4)	Fully accepted (n=4)
Drug dose too high (n=2)	Dosage changed (n=2)	Fully accepted (n=2)
Duration of treatment too long (n=2)	Monitoring required (n=2)	Fully accepted (n=2)
Problem: more suitable drug strength is available (n=2)		
Inappropriate drug form (n=2)	Formulation changed (n=2)	Accepted; not implemented (n=2)
Problem: wrong administration route (n=2)		
Drug administered via wrong route (n=2)	Instructions for use changed (n=2)	Fully accepted (n=2)

Note: *Includes intravenous incompatibility.