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Potential drug-to-drug interactions: a cross-sectional study among older patients discharged from hospital to home care

Rose Mari Olsen* and Hege Sletvold

Abstract

Background: There are major challenges in ensuring medication safety and preventing adverse drug events in older people. Older people are especially vulnerable to drug-to-drug interactions (DDIs). However, when older patients are transferred from hospital to home care, information related to DDIs is limited. The objectives of this study were to (1) identify and describe potential DDIs in older patients discharged from hospital to home care and (2) identify patient and hospital transfer characteristics associated with the potential DDIs.

Methods: This is a cross-sectional study of patients discharged from medical hospital wards to home care in central Norway. Nursing transfer documents, including medication lists, were reviewed from records of 99 older inpatients on the day of discharge. The patients' drug regimens were screened using the Norwegian drug interaction database, www.interaksjoner.no. Descriptive statistics and univariable and multivariable linear regression analyses were used to analyze the data.

Results: The mean age of the sample was 82.9 years; 58.6% were female. In total, 274 DDIs were identified. Major DDIs were identified in two patients, moderate DDIs in 80 patients, and minor DDIs in 40 patients. At least one potential DDI was found for 84 of the patients, with an average of 2.77 DDIs per patient. The most frequent DDIs were related to the concomitant use of alendronate and calcium. Warfarin treatments were frequently linked to DDIs. Potential DDIs were associated with the number of prescribed drugs, age, and living situation.

Conclusions: This study shows that potentially clinically relevant DDIs are common for older patients transferred from hospital to home care and pose a risk for these patients' health. Monitoring for potential DDIs is highly important to ensure patient safety, and home care nurses might play a significant role through awareness and early recognition.

Keywords: Drug-to-drug interactions, Older patients, Patient safety, Hospital discharge, Primary care, Norway

Background

Drugs are essential in the care and treatment of older patients, and used correctly, drugs contribute to better health and increased quality of life for many. However, there are major challenges in ensuring medication safety and preventing adverse drug events (ADEs) in older people [1–3]. A specific type of ADE, a drug-to-drug interaction (DDI), occurs when one drug changes the effect of another drug. Older people are especially vulnerable to DDIs and DDI-related adverse events because of age-related pharmacodynamic and pharmacokinetic changes, an increased risk for multimorbidity and, consequently, polypharmacy [4]. DDIs contribute to adverse drug reactions (ADR) and the burden of iatrogenic illnesses in older people [5]. They also increase hospital visits and admissions [6], hospital readmission [7], and mortality [8] and represent a significant burden in terms of healthcare costs [9].

For older people, discharge from hospital to home is an especially vulnerable situation. They often have complex care needs caused by multimorbidity and multiple functional limitations [10, 11]. In addition, the overlap of acute and chronic diseases when transferred from hospital may

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increase older patients' susceptibility to ADRs [5], including ADRs caused by DDIs. During hospitalization, extensive changes may be made in the patients' medication regimen [12], with prescription of new drugs causing new potential DDIs. After discharge, the patients most often face a drastic decrease in the number of supporting personnel to assist them in successfully complying with an often new and more complex drug regimen [13]. The patient might be without helping relatives and with sparse follow-up care from home health nursing; thus, the self-management skills of the patient are essential. The general practitioner (GP) must decide whether or not to maintain the change in the patient's medication regimen; however, incomplete communication about medication management between the hospital and GP at the time of discharge is common [12, 14]. In addition, discrepancies may occur between the hospital discharge medication list and the list of medications that the patient actually uses at home [15, 16].

Although numerous studies have evaluated potentially inappropriate medication use among older people, information related to DDIs in older patients transferred from hospital to home care is limited. The objectives of this study were to (1) identify and describe potential DDIs in older patients discharged from hospital to home care and (2) identify patient and hospital transfer characteristics associated with the potential DDIs.

Methods

Study setting and sample

A cross-sectional study using consecutive sampling was carried out at a general medicine ward and a geriatric unit at a local hospital in central Norway from August 2010 to June 2011. The sample consisted of nursing transfer documents and medication lists from records of older inpatients admitted from their own homes. The criteria for inclusion were that the patients were 70+ years of age and consent competent and that they received home health nursing both before and after the hospitalization. Contact persons at the hospital wards evaluated all patients for the inclusion criteria and enrolled the participants. A sample size of 100 was determined appropriate [17, 18]. Recruitment was challenging because many of the patients did not fulfill the criteria for receiving home health nursing after hospitalization: due to bad condition, they were discharged to a higher care level in primary care (i.e., nursing home). Overall, 111 patients met the inclusion criteria. Of these, nine refused to participate and three were excluded due to lack of information regarding medical prescriptions, leaving 99 patients enrolled in the study.

Data collection

Hospital transfer documents and background data were retrieved (by the contact persons) from the patient records on the day of discharge. Information on prescription drugs (drug names, dosage, and frequency) was collected from the physicians' discharge notes. These were attached to the nursing discharge notes because they contained medication information, intended for medication administration by home health nurses. Background data were used to identify patient characteristics (age, gender, living situation, housing situation, and distance from hospital) and hospital transfer characteristics (type of hospitalization, readmission status, medical department facility, and length of hospital stay).

Drug use and potential drug-to-drug interactions

All drugs were classified according to the Anatomical Therapeutic Chemical Classification (ATC) code. Variables of drug use included; prescribed drugs (in total), scheduled drugs, and drugs "as required" (pro re nata).

The potential DDIs were identified and evaluated by the interdisciplinary research team, i.e., a registered nurse (first author) and a pharmacist (second author). We used the database www.interaksjoner.no to check for DDIs. The database is maintained by the Norwegian Medicines Agency [19]. It contains information on both pharmacodynamic and pharmacokinetic drug interactions classified into three categories according to the "traffic light system" in terms of clinical relevance, i.e., assumed severity (major, moderate, minor). Red alerts in the database concern drug combinations to avoid (major), yellow alerts concern drugs that may be combined, but precautions need to be taken, e.g., dose changes or monitoring of clinical and/or laboratory parameters (moderate), and green alerts concern drugs where there is only a theoretical chance of a DDI, and drugs may be combined (minor). Some DDIs that appear in the database are clinically relevant only under specific circumstances, e.g., an interaction between warfarin and paracetamol, with a resulting increase in the international normalized ratio (INR) is only relevant if the doses of paracetamol are high, and treatment continues for several days. This was taken into account in our evaluation of the potential DDIs. However, it was not possible to assess whether all such circumstances were fulfilled, due to uncertainty in this information (e.g., paracetamol is often taken "as required"). The number of DDIs was classified on the basis of the pharmaceutical preparations instead of the pharmacological substances. Thus, the preparation Calcigran Forte® for example, which contains calcium and vitamin D, has only one DDI in combination with hydrochlorothiazide, although both calcium and vitamin D increase the risk of hypercalcemia in combination with hydrochlorothiazide. The database contains information on DDIs for ATC group levels (e.g., A10 drugs used in diabetes) that may not be clinically relevant for

all specific drugs in this ATC group, and these DDIs were not included in the results. For example, metformin (A10BA02) and the ACE-inhibitor enalapril apparently interact according to the database, resulting in an increased hypoglycemic effect; however, metformin does not increase the risk of hypoglycemia, and the DDI is not clinically relevant in this case.

Statistical analysis

SPSS version 23.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Descriptive statistics were expressed as medians and ranges or means and standard deviations (SD) for continuous variables (where appropriate) and as frequencies and percentages for categorical variables. Univariable analyses were performed to estimate the effect of covariates (patient and hospital transfer characteristics—used as categorical variables and number of prescribed drugs—used as a continuous variable) on the occurrence of potential DDIs. Variables showing a trend in association in univariable analysis ($p < 0.2$) were included in the multivariable linear regression analysis (using the Enter method) to control confounding effects. Several models were tested, and variables were removed until the remaining individual variables had a p value < 0.1. Two-sided p values < 0.05 were considered significant. Modeling results are reported as unstandardized and standardized regression coefficients, p values, and 95% confidence intervals.

Results

Characteristics of the study population

The mean age of the study population ($N = 99$) was 82.9 years (SD = 6.1; range = 70 to 95 years). As shown in Table 1, 58.6% were females. Most of the patients lived alone (69.7%), in their own homes (71.7%), and within a half hour driving time distance from the hospital (53.5%). With regard to the medical department, 32.3% of the patients were admitted to the geriatric unit and 67.7% to the general medicine ward. Most admissions were urgent (83.8%) and 25.3% were readmissions (within 30 days after discharge). The length of hospital stay varied between 1 and 24 days (mean = 7.12; SD = 4.5). The most common causes of hospitalization were pneumonia (31.3%) and chronic obstructive pulmonary disease (12.1%).

Table 1 Characteristics of the sample, $N = 99$

Characteristics	*n*	(%)
Patient characteristics		
Gender		
Male	41	(41.4)
Female	58	(58.6)
Age, years		
70–84	54	(54.5)
85–95	45	(45.5)
Living situation		
Living alone	69	(69.7)
Living with someone	30	(30.3)
Housing situation		
Sheltered housing	28	(28.3)
Own home	71	(71.7)
Distance from the hospital		
< ½ h	53	(53.5)
> ½ h	46	(46.5)
Hospital transfer characteristics		
Type of hospitalization		
Urgent	83	(83.8)
Elective	16	(16.2)
Readmission		
Yes	25	(25.3)
No	74	(74.7)
Medical department facility		
Geriatric	32	(32.3)
Non-geriatric	67	(67.7)
Hospital length of stay in days		
1–6	52	(52.5)
7–29	47	(47.5)

Drug use

The total number of drugs prescribed were 1108, including 978 scheduled drugs and 130 drugs to be taken "as required." On average, the patients used 11.3 drugs (median = 11, SD = 3.5), with a range of 2 to 25 drugs. All except one patient used five drugs or more. The number of scheduled drugs per patient was on average 9.88 (SD = 3.3; range = 2–21), and for "as required" drugs, the average per patient was 1.30 (SD = 1.4; range = 0–6).

In total, the patients used 156 different drugs (i.e., active substances). Of these, the most frequently prescribed drugs were prednisolone and metoprolol, both used by 51 of the patients (51.5%).

Potential drug-to-drug interactions

Among the 99 patients in the sample, we found at least one potential DDI for 84 (84.8%) of the patients: major DDIs were identified in two patients, moderate DDIs in 80 patients, and minor DDIs in 40 patients. In total, 274 DDIs were identified, with an average of 2.77 DDIs per patient (median = 2.0; SD = 2.36). The maximum number of potential DDIs identified was 10 in a regimen comprising 17 drugs. According to severity classification, 2 (0.7%) of the DDIs were major, 205 (74.8%) were moderate, and 67 (24.5%) were minor.

Antibiotic agents were involved in 38 DDIs, including the two drug combinations causing potential DDIs classified as major (identified in two different medication regimes): ciprofloxacin (ATC J01M A02) and melatonin (ATC N05C H01), and erythromycin (ATC J01F A01) and simvastatin (ATC C10A A01). In addition, amoxicillin, mycostatin, pivmecillinam, metronidazole, and phenoxymethylpenicillin were identified in potential DDIs.

Table 2 shows the most common potentially clinically relevant (moderate severity) DDIs identified, and a description of the mechanism, and possible precautions, for handling of the DDIs. These DDIs involved regularly used drugs, e.g., alendronate, calcium, warfarin, and paracetamol. Six drug combinations accounted for 37% of the moderate DDIs. Warfarin was frequently involved in potential DDIs, accounting for 24% ($N = 66$) of all the DDIs. In total, 80 dissimilar drug interaction pairs were identified.

Factors associated with potential DDIs

Results from both univariable linear regression and the multivariable linear regression analyses assessing the relationship between DDIs and independent variables are given in Table 3. Univariable analysis showed a statistically significant correlation between the number of potential DDIs and living situation (p value < 0.001), number of prescribed drugs (p value < 0.001), age (p value = 0.008), and housing situation (p value = 0.033). There was no significant relationship with gender, distance from hospital, type of hospitalization, length of hospital stay, readmission status, or hospital facility.

Multivariable linear regression analyses showed that age, number of prescribed drugs, and living situation were significantly associated with DDIs, after controlling for the housing situation. These variables accounted for approximately 47% of the variability in DDIs (p value < 0.001) (Table 3). Age has a negative influence on DDIs, i.e., patients of a younger age are more likely to experience DDIs. Patients living with someone are also more likely to have DDIs than patients living alone. For every one-unit increase in the number of drugs, the number of DDIs increases by on average 0.33.

Discussion

The objectives of this study were to identify and describe potential DDIs in older patients discharged from hospital

Table 2 The most common potential clinically relevant drug-to-drug interactions (DDIs) in 99 older patients discharged from hospital to home care

Drug-to-drug interaction (ATC code)	Example of drug combinations	Number of patients	Mechanism of interaction	Potential precautions or handling of the drug-to-drug interaction
Alendronate (M05B A04)–calcium carbonate/vitamin D_3 in combination (A12A X-)	Fosamax®–Calcigran Forte®	16	When taken simultaneously per os, calcium-containing drugs may decrease the absorption of peroral bisphosphonates.	Bisphosphonates should be taken at least 1 h before or 2 h after the calcium-containing drugs. For drugs containing more than 1000 mg of calcium, bisphosphonates should be taken at least 3 h before calcium.
Warfarin (B01A A03)–paracetamol (N02B E01)	Marevan®–Paracet®	14	Paracetamol may reduce the concentration of some coagulation factors and increase the effect of warfarin, with an increase in INR. The use of 1 g paracetamol 4 times per day for 3–4 days consecutively increased INR with a mean of 0.5 units.	Monitor INR during concomitant use. The use of paracetamol in combination with warfarin is far safer than using for example. NSAIDs when analgesics are required.
Digitalis glycosides (C01A)–high-ceiling diuretics (C03C)[a]	Digitoxin®–Furix®	12	Loop-diuretics may result in hypokalemia and consequently lead to an increased toxicity of digitoxin, although its blood concentrations remain unchanged.	Monitor blood potassium concentration.
Warfarin (B01A A03)–prednisolone (H02A B06)	Marevan®–Prednisolon®	12	Unclear mechanism. INR may increase when combining warfarin with high-dose glucocorticoids.	Monitor INR and adjust warfarin dosage.
Benzodiazepine-related drugs (N05C F)–opioids (N02A)[a]	Zopiclone®–OxyNorm®	11	Increased sedative effects. Sporadic combination of the drugs is acceptable.	Clinical monitoring for sedative effects. Special consideration of this drug combination is required in frail, elderly patients with non-malign pain.
Warfarin (B01A A03)–allopurinol (M04A A01)	Marevan®–Zyloric®	10	Unclear mechanism. Allopurinol may inhibit the metabolism of warfarin in some individuals and thereby increase the effect of warfarin, and INR.	Monitor INR and adjust warfarin dosage.

All DDIs were classified as moderate (drugs may be combined but precautions must be taken) according to the Norwegian database www.interaksjoner.no. The description of mechanism and possible precautions and handling is also based on this database

INR international normalized ratio, *NSAIDs* non-steroidal anti-inflammatory drugs

[a]These interactions are described on a higher level of ATC codes involving several active substances

Table 3 Univariable and multivariable linear regression analysis for drug-to-drug interactions in older patients discharged from hospital, $N = 99$

Variables	Univariable				Multivariable			
	Coefficient *B*	95% CI	*p* value	Standardized *β*	Coefficient *B*	95% CI	*P* value	Standardized *β*
Gender								
Male	Ref							
Female	0.020	− 0.941 to 0.980	0.968	0.004				
Age, year								
70–84	Ref				Ref			
85–95	− 1.244	− 2.161 to − 0.328	0.008	− 0.264	− 1.104	− 1.821 to − 0.387	0.003	− 0.234
Living situation								
Living alone	Ref				Ref			
Living with someone	2.390	1.480 to 3.300	< 0.001	0.468	1.236	0.377 to 2.095	0.005	0.242
Housing situation								
Sheltered housing	Ref				Ref			
Own home	1.120	0.094 to 2.146	0.033	0.215	0.129	− 0.693 to 0.951	0.756	0.025
Distance from the hospital								
< ½ h	Ref							
> ½ h	− 0.541	− 1.483 to 0.402	0.258	− 0.115				
Type of hospitalization								
Urgent	Ref							
Elective	0.650	− 0.629 to 1.928	0.316	0.102				
Readmission								
Yes	Ref							
No	0.438	− 0.647 to 1.524	0.425	0.081				
Medical department facility								
Geriatric	Ref							
Non-geriatric	0.442	− 0.566 to 1.449	0.386	0.088				
Hospital length of stay								
1–6 days	Ref							
7–29 days	0.564	− 0.377 to 1.504	0.237	0.120				
Number of prescribed drugs[a]	0.405	0.295 to 0.515	< 0.001	0.595	0.331	0.219 to 0.443	< 0.001	0.487

CI confidence interval
[a]Number of prescribed drugs was the only independent variable used as a continuous variable

to home care and to identify patient and hospital transfer characteristics associated with potential DDIs. Potential DDIs, particularly moderate ones, were common in this population (84.8%). This is in agreement with Marusic et al. [20] who found potential DDIs in 85.6% (190 out of 222) of older patients discharged from an internal medicine clinic in Croatia, but somewhat in contrast to Pasina et al. [8] who reported potential DDIs in 60.5% (1642 out of 2712) of an equivalent patient group in Italy. A major limitation in our study is the lack of information on whether or not the potential DDIs actually led to ADRs or a change of therapeutic effect. Marusic et al. [20] followed patients for 30 consecutive days after discharge and detected actual DDIs in 21 (9.5%) of the patients, where two lacked therapeutic effect and 19 experienced ADRs. Thus, our results almost certainly overestimate the prevalence of actual DDIs. Furthermore, the patients may not take all drugs as prescribed, and prescribers may be well aware of the DDIs, e.g., have adjusted the dosage or followed monitoring parameters.

The most common DDIs identified in this study (Table 2) are in accordance with other studies. Warfarin is well known for its DDI potential [20], as are digitalis glycosides [9]. In addition, a high number of DDIs concerning alendronate and calcium carbonate/vitamin D_3 were detected in this sample, and these drugs are frequently combined for the treatment of osteoporosis. In order to avoid reduced absorption of alendronate, drugs

need to be taken at different time points during the day [21]. Therefore, the prevention of this DDI is left to the patient or the home health nurse administering the drugs. This may be challenging, not least because the patients at discharge often are in a vulnerable state, and may have physical and cognitive impairment. Corbett et al. [15] found that 40% of older patients had one or more medication discrepancies at the patient level, e.g., intentional and non-intentional non-adherence and not filling prescriptions, when transferred from hospital to home. Consequently, the patient's self-management skills that are taught by the home health nurse are essential. In the study of Sino et al. [22], 80.3% of the home health nurses felt responsible for their older patients' proper medication use, but the mean score for knowledge of drug interactions was 77% of the maximum score.

Fortunately, the DDIs most frequently described in our study may be preventable and/or manageable if the prescribers have the complete overview of the patient's drug use. However, drugs taken "as required" may cause special challenges in terms of DDIs, generating transient DDIs that may be difficult to detect [4]. In this study, the concomitant use of warfarin and paracetamol may be worth noting (Table 2). Paracetamol in high doses may increase the INR [19]. A meta-analysis of seven randomized controlled trials ($N = 225$ patients) found that paracetamol was associated with a mean 0.62 INR increase (95% CI 0.46–0.78) compared to a placebo, when the daily dosage of paracetamol was in the range of 1–4 g [23]. Thus, the patients using warfarin that increased their doses of paracetamol without informing the physician may be at increased risk of bleeding. Corbett et al. [15] reported that older patients transferred from hospital to home reported substituting prescribed pain medication with pain medication they had at home. To substitute paracetamol for non-steroidal anti-inflammatory drugs (NSAIDs), resulting in a contraindicated DDI [19], may have deleterious effects on the risk of bleeding. Moreover, the warfarin interaction potential requires awareness, and this study identified warfarin as responsible for a quarter of the potential DDIs, including combination with the corticosteroid prednisolone. A study of 32 patients on long-term warfarin therapy that initiated short-term oral corticosteroid therapy found a mean difference between pre- and post-INR values of 1.24 (95% CI 0.86–1.62), and 16 patients (50%) required a modification of warfarin therapy [24]. Thus, identification of warfarin drug combinations to avoid, or ones that require precautions, is essential to ensure the necessary monitoring and adjustment of dosages.

As the patients in the present study were transferred from hospital, the use of antibiotics in the study sample was common and can be related to the frequent causes of hospitalization, i.e., pneumonia and chronic obstructive pulmonary disease. Therefore, we chose to focus on DDIs involving prescribed antibiotic drugs. Antibiotic agents were involved in 38 DDIs, of which two were contraindicated. These DDIs may pose a particular challenge to patient safety, as the GP may neither be involved in patient care nor get timely information from the hospital doctor after discharge. Viktil et al. [12] found that only 24 out of 105 discharge notes of older patients discharged from general medicine departments at Norwegian hospitals were received within a week by the GPs. In the same study, they found that extensive changes were made in drug regimens, both during hospitalization and in the initial months after discharge (3.4 versus 4.4 drug changes per patient, respectively). Bakken et al. [25] studied patients transferred from hospital to an intermediate-care nursing home unit or hospital ward, and they found an increase in the number of drugs from admission to discharge, mainly due to treatment of infections and pain.

The finding of an association between DDIs and the number of prescribed drugs is in accordance with several other studies [e.g., 9, 26]. Age as a predictor of DDIs has also been reported in previous research [e.g., 9]. However, in contrast to most other studies, we found that the number of DDIs decreases with age: Patients aged 70–84 years had significantly more DDIs than those aged 85–95, even when controlling for other variables. Fialova et al. [27], in a study of potentially inappropriate medication (PIM) use in older patients ($N = 2707$) receiving home care in eight European countries, found that PIM use was negatively associated with age for patients of 85 years and older. The authors suggest that this finding could be explained by greater physician awareness of PIM in the oldest patients, or by a higher mortality rate in this age group. Although Fialova et al. did not include DDIs in their criteria for PIM, their explanation may also be transferrable to our findings.

Our result showing an association between DDIs and living situation, i.e., those living with someone are more likely to have DDIs, was somewhat surprising. A possible explanation may be that patients living with someone receive help from their relatives and, consequently, receive less follow-up care from the healthcare services. Unfortunately, we do not have information about frequency of assistance provided by the home health nursing services in order to investigate this hypothesis.

Strengths and weaknesses

The small sample size, and the use of consecutive sampling, limits the validity and generalizability of the results. Although the patients in the sample were representative of those in the hospital in terms of age and gender, a selection bias may have occurred since we only enrolled patients

with informed consent (and excluded those with cognitive impairments, e.g., dementia).

This cross-sectional study used correlational analysis in certain aspects, and therefore, only associations and not causal relationships can be established. There is no way to establish temporal sequences—that is, for example, which came first the "DDIs" or the "Number of prescribed drugs used." According to R-squared, the model explained 47% of the variance in DDI. This fact suggests that other patient and transfer characteristics were likely to be of importance.

The identification and assessment of potential DDIs was performed by a registered nurse (first author) and a pharmacist (second author), and this interdisciplinary approach strengthens the analysis. We chose to use the Norwegian drug interaction database [19], as this is a well-known database in Norway, based on data from the Norwegian Medicines Agency's decision support system. Both prescribers and pharmacists use this database. DDI databases differ in the level of documentation and classification of DDIs [28], and our results may have been different if we had used other databases.

This study was concerned with potential DDIs based on medication lists, and no attempt was made to determine whether the patients actually took the medications or whether the interaction resulted in clinically relevant DDIs. Studies have shown that errors in the medication lists at the time of discharge from hospitals are common [16]. Future research needs to assess the prevalence of clinically relevant DDIs in older patients discharged from hospital to home care.

Implications

Older patients discharged from hospital to home care are frequently exposed to potential DDIs, and this requires special awareness among healthcare professionals. In their roles as caregivers and administrators of medications, with regular contact with the patients, home care nurses are particularly well positioned to be the most astute observers of DDIs and can recognize and monitor relevant clinical symptoms. Thereby, nurse-led structured medication monitoring can be effective in preventing DDIs, as previously described as an intervention to reduce adverse drug reactions [29]. However, further studies are needed to explore the potential benefits of such interventions. A qualitative study from Sweden show that registered nurses working in home care settings for older patients can contribute in pharmacovigilance regarding these patients' drug treatment [30]. Ensuring safe and effective drug treatment for the individual patient should involve interprofessional strategies. An interdisciplinary team including GPs, nurses, and pharmacists can utilize the integrated medicines management (IMM) model [31], which includes medication reconciliation, medication review, and patient education, with the aim of preventing and reducing DDIs as well as other ADEs. Thereby, a multi-disciplined, professional team can contribute to medication safety for home-dwelling older patients after hospital discharge.

Conclusions

The present study shows that potential DDIs are frequent among older patients discharged from hospital to home and that DDIs might be associated with the number of prescribed drugs, patient age, and living situation. Monitoring for potential DDIs is highly important to ensure patient safety. In addition to the GP and pharmacist, home care nurses, who visit their patients in their homes on a regular basis, can assist in early recognition of potential DDIs in home-dwelling, older patients after hospital discharge and thereby contribute to the safe use of medicines.

Abbreviations

ADE: Adverse drug events; ADR: Adverse drug reactions; ATC: Anatomical Therapeutic Chemical Classification; DDI: Drug-to-drug interactions; GP: General practitioner; INR: International normalized ratio; PIM: Potentially inappropriate medication; SD: Standard deviation

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Available of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

RMO designed the study and collected the data. RMO and HS identified and evaluated the potential DDIs. RMO conducted the statistical analysis, created the tables, and led the drafting of the manuscript. RMO and HS were both involved in critically revising the manuscript for important intellectual content and both read and approved the final manuscript.

Ethics approval and consent to participate

The research project was approved by The Committee for Medical and Health Research Ethics of Norway (no. 2009/815) and carried out in accordance with the Declaration of Helsinki. Informed consent was obtained from all patients.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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