ORIGINAL ARTICLE

Potentially Inappropriate Medication Usage among Older Emergency Department Patients in a Middle-Income Country

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Objective: To investigate the prevalence of potentially inappropriate medications (PIMs) prescriptions among older patients in the ED based on Beers criteria 2015 and Screening Tool of Older People's Prescriptions (STOPP) criteria 2015 and to assess the prevalence of patients who return to the ED for treatment due to adverse drug reactions (ADRs), rates of ED revisit, and rates of mortality within 30 days.

Materials and Methods: This retrospective descriptive study was conducted at a single center and included a random sample of patients aged 65 years or older who presented to the ED and received at least one medication in the ED during a 4-month period. Patients were excluded if they received any medications within 1 day before or after the ED visit, experienced cardiac arrest upon ED arrival, intentionally overdosed on drugs, or had incomplete documentation or missing medical records.

Results: Our study comprised 370 patients, 93 (25.1%) of whom were found to have been prescribed PIMs according to the Beers criteria. Among these patients, 19 (20.4%) revisited the ED within 30 days, with 3 (3.2%) cases related to ADRs. Similarly, using the STOPP criteria, 86 patients (23.2%) were identified as having been prescribed inappropriate medications, with 18 (20.9%) of them revisiting the ED within 30 days and 5 (5.8%) cases related to ADRs. In comparing ED revisits between both groups, categorized by the Beers criteria and STOPP criteria, the odds ratios were calculated as 2.37 (95% confidence interval [CI] = 1.25 to 4.51) and 2.42 (95% CI = 1.26 to 4.63), respectively.

Conclusions: One-fourth of the patients who arrived at the ED received PIMs according to the Beers criteria and STOPP criteria. Further studies may be required to evaluate the impact and reduce the incidence of ADRs, thus identifying best practices for prescribing to older patients in the ED.

Keywords: Emergency department; Potentially inappropriate medication; Beers 2015; STOPP 2015

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By 2050, the number of persons aged 65 years or older worldwide is projected to more than double[1]. The aging process is associated with physiologic changes of multiple organ systems, contributing to functional impairment and chronic comorbidities, which in turn lead to the use of multiple medications[2]. Due to alterations in age-related pharmacokinetics and pharmacodynamics, older adults are at high risk for drug-related problems, including adverse drug reactions (ADRs), drug–disease interactions, drug–drug interactions, and potentially inappropriate medications (PIMs)[3,4].

PIMs are medications that should be avoided in the older population because the risk of use outweighs their benefits and for which there are safer or more effective alternatives[5]. PIMs have become a public health concern, associated with negative health consequences, including ADRs, functional decline, emergency department (ED) visits, hospitalization, and death[6-9]. The prevalence of PIM use in older outpatients has been reported to range from 1.3% to 95.2%, varying by different geographic regions and World Bank countries. The estimated pooled prevalence of PIM use is 33.2% in high-income countries, 39.5% in upper- to middle-income countries, 40.8% in lower- to middle-income countries, and 56.3% in low-income countries[10]. In Thailand, the prevalence of PIM prescription among older patients was reported to vary by patient settings at 40.4% to 65.9% in primary care[11-13] and 63.9% in the outpatient department[9].

Considering patient safety, various criteria-based tools have been developed to minimize inappropriate medication use and assist physicians with medication management in

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older people[14-16]. The two most widely used explicit criteria are the American Geriatric Society Beers criteria[5] and the Screening Tool of Older People's Prescriptions (STOPP) criteria[17]. Beers criteria were originally developed in America in 1991 and were updated in 2023[5]. STOPP criteria were created in Europe, with the latest version published in 2023[17].

Due to the increase in the aging population, older adults have a higher tendency toward ED utilization because of their health fragility as compared with individuals of younger age groups[18,19]. Several studies on the prescription of PIMs in older adults have been conducted in primary care and outpatient settings[9,11-13]. However, little is known about PIM prescription for older ED patients in middle-income countries, which may have differences in their health systems compared with others.

In the present study, the authors aimed to determine the prevalence of PIM prescriptions according to Beers criteria 2015[20] and STOPP criteria 2015[21] among Thai older adults presenting to the ED. In addition, the authors evaluated the prevalence of patients who returned for treatment due to ADRs, rates of revisiting the ED, and mortality rate within 30 days.

Materials and Methods

Study design and population

This was a retrospective descriptive study of older adults presenting to the ED at an urban academic hospital between January 1, 2016, and May 1, 2016. The hospital's electronic medical records were reviewed to identify eligible subjects. Patients were included in the present study if they were aged 65 years or older, prescribed at least one medication in the ED, and capable of 30-day follow-up. The authors excluded patients who received any medications within 1 day before or after the ED visit, experienced cardiac arrest upon ED arrival, intentionally overdosed on drugs, or had incomplete documentation or missing medical records. To calculate the sample size, the authors used the W.G. Cochran formula, assuming a 30% prevalence of PIMs, a maximum error of 5%, and a confidence level of 95%. A sample size of 323 patients was determined. Subsequently, a random sample of 400 individuals from this eligible group was collected using a random generator program. The present study was approved by the Institutional Review Board Faculty of Medicine Vajira Hospital (No. 120/2559).

Data collection and measures

A research assistant (RA) performed data collection. The RA was a pharmacist. Data were extracted from the electronic medical records. The authors determined the prevalence of PIM following the Beers criteria 2015 and STOPP criteria 2015. The authors compared patient demographic characteristics including age, gender, chief complaints, Charlson Comorbidity Index (CCI), number and type of medications, ED revisit rate, rates of ED revisit due to ADRs, and mortality rate within 30 days following PIM prescriptions between Beers criteria 2015 and STOPP criteria 2015.

Definitions

Polypharmacy was defined as the concurrent use of five or more medications[22]. ADR was defined as a harmful or unwanted reaction attributed to the use of medication[23]. In the present study, an ADR was identified according to the Naranjo criteria. Potential drug-drug interactions were identified using http://www.webmd.com/interaction-checker/.

Data analysis

Categorical variables are presented as values and percentages, and continuous variables are presented as medians and interquartile ranges (IQRs). The authors used Fisher's exact test to analyze variables of patients with PIM, comparing Beers criteria 2015 and STOPP criteria 2015. The risk of ED revisits and hospitalization was described by odds ratios (ORs) and 95% confidence intervals (CIs). A p-value of >0.05 indicates statistical significance. The study data were analyzed using STATA version 13.1 used to compare proportions, and an independent Student's t-test was used to analyze the mean differences between the groups. A p-value less than 0.05 indicated statistical significance.

Results

Of 2,081 eligible patients, 400 patients were randomized. The authors excluded twenty-six patients due to incomplete or missing hospital records and four patients who experienced cardiac arrest upon arrival at the ED. Among the 370 included patients, the median age was 77 years (IQR 72 to 83 years), and 63.8% were female. The prevalence of PIM prescriptions was 25.1% as detected by Beers criteria 2015, compared with 23.2% as detected by STOPP criteria 2015. A total of 115 (31.1%) patients were prescribed PIMs according to both criteria.

As shown in Table 1, most patients who were prescribed PIMs presented to the ED with complaints of vertigo and dyspnea, had a median CCI score of 4 (IQR 3 to 5), and received four or fewer medications per prescription according to both criteria. Approximately one-fifth of the patients prescribed PIMs returned to the ED within 30 days (with 3.2% to 5.8% of ED revisits being due to ADRs). Among the 5 ED revisits due to ADR, chief complaints included 2 falls (one received orphenadrine and diclofenac, and one received dimenhydrinate), 1 syncope (received lorazepam), 1 delirium (received haloperidol), and 1 stupor

Table 1. Comparison of patient characteristics using Beers 2015 versus STOPP 2015 criteria

Characteristics	Total, n=370	Beers 2015, n=93 (25.1%)	STOPP 2015, n=86 (23.2%)
Age (year), median (IQR)	77 (72 to 83)	75 (69 to 83)	75 (69 to 81)
Age (year) group, n (%)			
65 to 74	150 (40.5)	43 (46.2)	41 (47.7)
75 to 84	158 (42.7)	34 (36.6)	35 (40.7)
≥85	62 (16.8)	16 (17.2)	10 (11.6)
Gender, n (%)			
Female	236 (63.8)	71 (76.3)	60 (69.8)
Symptoms, n (%)			
Dyspnea	70 (18.9)	10 (10.8)	10 (11.6)
Vertigo	22 (6.0)	18 (19.4)	16 (18.6)
Abdominal pain	27 (7.3)	7 (7.5)	2 (2.3)
Fever	32 (8.7)	4 (4.3)	4 (4.7)
Altered mental status	22 (6.0)	1 (1.1)	2 (2.3)
Chest pain	14 (3.8)	2 (2.2)	2 (2.3)
Diarrhea	12 (3.2)	3 (3.2)	1 (1.2)
Charlson Comorbidity Index, median (IQR)	4 (3-5)	4 (3-5)	4 (3-5)
Number of medications per prescription, n (%)			
≤4	264 (71.4)	61 (65.6)	64 (74.4)
>4	106 (28.6)	32 (34.4)	22 (25.6)
Hospital admissions, n (%)	151 (40.9)	18 (19.3)	15 (17.4)
30-day adverse outcomes, n (%)			
ED revisits within 30 days	46 (12.4)	19 (20.4)	18 (20.9)
ED revisits due to ADRs	5 (1.4)	3 (3.2)	5 (5.8)
Hospital admissions within 30 days	157 (42.4)	23 (24.7)	19 (22.1)
30-day mortality	1 (0.3)	0 (0)	0 (0.0)

Table 2. Most frequently prescribed PIMs by Beers 2015 versus STOPP 2015 criteria

Beers 2015 Medications, n (%)		STOPP 2015 Medications, n (%)	
First-generation antihistamines	37 (39.8)	First-generation antihistamines	47 (54.7)
Gastrointestinal	32 (34.4)	Opioids	23 (26.8)
NSAIDs	16 (17.2)	NSAID's if eGFR <50 ml/min/1.73 m^2	20 (23.3)
Skeletal muscle relaxants	9 (9.7)	Benzodiazepines	6 (7.0)
Benzodiazepine	7 (7.5)	NSAID and vitamin K antagonist, direct thrombin inhibitor or factor Xa inhibitors in combination	1 (1.2)

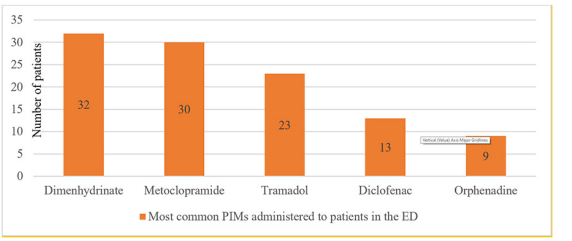

Figure 1. Most common PIMs administered to patients in the ED.

(received dimenhydrinate).

Figure 1 and Table 2 present the top 5 most frequently prescribed PIMs, with dimenhydrinate being the most prevalent. Other commonly prescribed PIMs included metoclopramide, tramadol, diclofenac, and orphenadrine. Notably, Table 3 highlights common drugs that were concomitantly prescribed and potentially capable of causing serious drug-drug interactions, such as clopidogrel-omeprazole (1.9%).

PIMs were significantly associated with a higher rate of ED revisit within 30 days according to both Beers criteria (20.4%, OR 2.37, 95% CI=1.25 to 4.51) and STOPP criteria (20.9%, OR 2.42, 95% CI=1.26 to 4.63) (Table 4).

Among the five patients who returned to the ED within 30 days due to ADRs, three patients received PIMs according to Beers criteria, and five patients received PIMs according to STOPP criteria. The number of PIMs was found to be significantly associated with 30-day ED revisits due to ADRs based on Beers criteria (p=0.036), whereas the association was not statistically significant based on STOPP criteria (p=0.096) (Table 5).

Table 3. Potential serious drug–drug interactions

Drug – drug interactions	n (%)
Clopidogrel and Omeprazole	7 (1.9)
Amlodipine and Simvastatin	4 (1.1)
Prednisolone and Simvastatin	4 (1.1)
Ciprofloxacin and Simethicone	4 (1.1)
Ceftriaxone injection and Warfarin	3 (0.8)

Table 4. Rates of ED revisit within 30 days after receiving PIMs by Beers 2015 versus STOPP 2015 criteria

	ED revisits within 30 days		Odds ratio (95% CI)	p-value
	Yes, n (%)	No, n (%)		
Beers 2015				
Yes	19 (20.4)	74 (79.6)	2.37 (1.25 to 4.51)	0.008
No	27 (9.8)	250 (90.3)	1.00	
STOPP 2015				
Yes	18 (20.9)	68 (79.1)	2.42 (1.26 to 4.63)	0.008
No	28 (9.9)	256 (90.1)	1.00	

Table 5. Rate of 30-day ED revisits due to ADRs after receiving PIMs by Beers 2015 versus STOPP 2015 criteria

Number of PIMS	30-day ED revisits due to ADRs		p-value
	Yes	No	
Beers 2025			0.036
1	1 (1.3)	76 (98.7)	
2	1 (8.3)	11 (91.7)	
3	0 (0)	2 (100.0)	
≥4	1 (50.0)	1 (50.0)	
STOPP criteria 2015			0.096
1	4 (5.3)	72 (94.7)	
2	0 (0.0)	7 (100.0)	
3	0 (0.0)	2 (100.0)	
≥4	1 (100.0)	0 (0.0)	

Discussion

In the present study, the authors found that the prevalence of PIM prescription among older ED patients was 25.1% and 23.2% as identified by Beers criteria 2015 and STOPP criteria 2015, respectively. The observed prevalence of PIM prescriptions in our study was lower than that reported in older ED patients in other countries: 79.2% in Korea using country-specific criteria[24]; 42.1% versus 63.7% in Taiwan using country-specific criteria versus Beers criteria 2015, respectively[25]; 55% in Indonesia using Beers criteria 2015[26]; and 30.2% in the United States using Beers criteria 2015[27]. These differences might be attributed to variations in available medications, disease profiles, prescribing preferences, and practice guidelines across different countries. Chang et al. reported a marked difference in PIM prescription rates of 42.1% versus 63.7% using country-specific (Taiwan PIM criteria) and Beers criteria 2015, respectively, and recommended country-specific PIM criteria as the reference for clinical practice in the ED[25].

According to both Beers and STOPP criteria, the most frequently prescribed PIM was dimenhydrinate. Dimenhydrinate is a first-generation antihistamine that exhibits anticholinergic activity. This is relevant to the most common complaint in the ED, vertigo, which can be treated with dimenhydrinate. According to the Anticholinergic Cognitive Burden Scale (ACBS), dimenhydrinate has a score of three. ACBS scores greater than two in older adults are associated with a significant risk of readmission, ED revisits, and all-cause ED visits[28,29]. Kim et al. and Gardner et al. identified ketorolac tromethamine and ibuprofen as commonly administered PIMs, respectively[24,27]. In our study, the authors found tramadol to be the second most commonly prescribed PIM followed by diclofenac according to STOPP criteria. Although tramadol is not included in the 2015 Beers criteria[20], it is included in the 2023 Beers criteria as a PIM for delirium[5]. This preference for tramadol over nonsteroidal anti-inflammatory medications (NSAIDs) may be due to concerns regarding the gastrointestinal adverse effects and reduced renal function associated with NSAIDs in older adults. However, it is important to note that O-desmethyltramadol, the active metabolite of tramadol, exhibits larger distribution and slower clearance in older adults compared with younger individuals. This can result in a higher maximum possible treatment-related effect and an increased potential for side effects at the same dose[30]. In addition, the use of tramadol is associated with a risk of hyponatremia, delirium, fall, and hip fracture[31,32].

The most commonly prescribed drug combination that can potentially cause serious drug–drug interactions was clopidogrel–omeprazole (1.9%). The concomitant use of clopidogrel and omeprazole lowers the level of clopidogrel, resulting in increased platelet activity[33]. Polypharmacy is a risk factor for potential drug–drug interaction exposure. As the number of medications increases, the potential for drug interactions also increases[34]. Dookeeram et al. found that the prevalence of drug–drug interactions in older ED patients was about 1.5 times higher than that in younger patients[35].

The authors found that PIMs were significantly associated with a higher rate of ED revisit within 30 days according to both Beers criteria (20.4%, OR 2.37, 95% CI = 1.25 to 4.51) and STOPP criteria (20.9%, OR 2.42, 95% CI = 1.26 to 4.63), which is consistent with the findings of several other studies[29,36]. Hammouda et al. reported a 20.45% rate of ED revisits in older adults who were discharged from the ED within 3 and 30 days[36]. In addition, the study by Liang et al. showed that PIMs and polypharmacy were significantly associated with ED revisits and readmission within 1 and 3 months[29].

ED patients are generally critically ill and require urgent therapy. Although medications administered in the ED are typically short term and given as a one-time dose, serious negative health outcomes can occur with even a single dose. Therefore, PIMs should be recognized, and physicians should exercise cautious in prescribing medications to older adults in the ED. In addition, older patients should be monitored for medication-related problems.

Limitations

As a retrospective study, this research relied on data from an electronic source, from which some data were missing or incomplete. Because certain patients may not return for treatment at our hospitals, the rates of ED revisits might be underreported. In addition, due to the limited number of inpatient beds, some patients might need to stay in the ED until discharged or referred to other hospitals. Furthermore, 26 medications listed in the Beers criteria 2015 are not available in Thailand, potentially contributing to the low prevalence of PIMs in our study.

Conclusions

According to the Beers 2015 criteria and STOPP 2015 criteria, one-fourth of patients who visited the ED received PIMs. In the future, further studies may be necessary to assess the impact and reduce the incidence of ADRs, thereby identifying best practices for prescribing to older ED patients in Thailand.

What is already known on this topic?

Aging may lead to the development of more diseases and the subsequent use of various medications in older populations, potentially resulting in problems related to the prescription of PIMs. The use of PIMs in older patients from middle-income countries has not been well identified.

What this study adds?

The present study shows that one-fourth of older patients who visited the ED received PIMs.

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Conflicts of interest

The authors declare no conflict of interest.

References

1. United Nations, Department of Economic and Social Affairs, Population Division. World population prospects 2022: summary of results. New York: United Nations; 2022.
2. Rodrigues DA, Herdeiro MT, Figueiras A, Coutinho P, Roque F, Rodrigues DA, et al. Elderly and polypharmacy: physiological and cognitive changes. In: Palermo S, editor. Frailty in the elderly - understanding and managing complexity [Internet]. IntechOpen; 2020 [cited 2022 Dec 23]. Available from: https://www.intechopen.com/chapters/71815.
3. Wastesson JW, Morin L, Tan ECK, Johnell K. An update on the clinical consequences of polypharmacy in older adults: a narrative review. Expert Opin Drug Saf 2018;17:1185-96.
4. Corsonello A, Pedone C, Incalzi RA. Age-related pharmacokinetic and pharmacodynamic changes and related risk of adverse drug reactions. Curr Med Chem 2010;17:571-84.
5. American Geriatrics Society 2023 updated AGS Beers Criteria® for potentially inappropriate medication use in older adults. J Am Geriatr Soc [Internet]. 2023 [cited 2024 Apr 6];71:2052-81. Available from: https://agsjournals.onlinelibrary.wiley.com/doi/10.1111/jgs.18372.
6. do Nascimento MM, Mambrini JV, Lima-Costa MF, Firmo JO, Peixoto SW, de Loyola Filho AI. Potentially inappropriate medications: predictor for mortality in a cohort of community-dwelling older adults. Eur J Clin Pharmacol 2017;73:615-21.
7. Weir DL, Lee TC, McDonald EG, Motulsky A, Abrahamowicz M, Morgan S, et al. Both new and chronic potentially inappropriate medications continued at hospital discharge are associated with increased risk of adverse events. J Am Geriatr Soc 2020;68:1184-92.
8. Jeon HL, Park J, Han E, Kim DS. Potentially inappropriate medication and hospitalization/emergency department visits among the elderly in Korea. Int J Qual Health Care 2018;30:50-6.
9. Varavithya V, Tirapat C, Rojpibulstit P, Poovichayasumlit P, Prasert V, Vatcharavongvan P. Potentially inappropriate medication use and the hospitalization rate among Thai elderly patients: a retrospective cohort study. Eur J Clin Pharmacol 2022;78:847-55.
10. Tian F, Chen Z, Zeng Y, Feng Q, Chen X. Prevalence of use of potentially inappropriate medications among older adults worldwide: A systematic review and meta-analysis. JAMA Netw Open 2023;6:e2326910.
11. Vatcharavongvan P, Puttawanchai V. Potentially inappropriate medications among the elderly in primary care in Thailand from three different sets of criteria. Pharm Pract (Granada) 2019;17:1494. doi: 10.18549/PharmPract.2019.3.1494.
12. Ananchaisarp T, Chamroonkiadtikun P, Komolsuradej N. Prevalence of potentially inappropriate medication and its associated factors in elderly patients in the primary care unit of a university hospital of southern thailand. J Med Assoc Thai 2018;101:1575-82.

13. Vatcharavongvan P, Prasert V, Ploylearmsang C, Puttawanchai V. Prevalence and Factors that Influence Potentially Inappropriate Medication Use among Thai Elderly in Primary Care Settings. Can Geriatr J 2021;24:332-40.
14. Curtin D, Gallagher PF, O'Mahony D. Explicit criteria as clinical tools to minimize inappropriate medication use and its consequences. Ther Adv Drug Saf 2019;10:2042098619829431.
15. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. Tools for assessment of the appropriateness of prescribing and association with patient-related outcomes: A systematic review. Drugs Aging 2018;35:43-60.
16. Motter FR, Fritzen JS, Hilmer SN, Paniz É V, Paniz VMV. Potentially inappropriate medication in the elderly: a systematic review of validated explicit criteria. Eur J Clin Pharmacol 2018;74:679-700.
17. O'Mahony D, Cherubini A, Guiteras AR, Denkinger M, Beuscart JB, Onder G, et al. STOPP/START criteria for potentially inappropriate prescribing in older people: version 3. Eur Geriatr Med 2023;14:625-32.
18. Lumjeaksuwan M, Patcharasopit S, Seksanpanit C, Sritharo N, Aeampuck A, Wittayachamnankul B. The trend of emergency department visits among the elderly in Thailand. WHO South East Asia J Public Health 2021;10:25-8.
19. Keskinoğlu P, İnan F. Analysis of emergency department visits by elderly patients in an urban public hospital in Turkey. J Clin Gerontol Geriatr 2014;5:127-31.
20. American Geriatrics Society 2015 Beers Criteria Update Expert Panel. American Geriatrics Society 2015 updated beers criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc 2015;63:2227-46.
21. O'Mahony D, O'Sullivan D, Byrne S, O'Connor MN, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. Age Ageing 2015;44:213-8.
22. Guillot J, Maumus-Robert S, Bezin J. Polypharmacy: A general review of definitions, descriptions and determinants. Therapie 2020;75:407-16.
23. Edwards IR, Aronson JK. Adverse drug reactions: definitions, diagnosis, and management. Lancet 2000;356:1255-9.
24. Kim K, Jung J, Kim H, Kim JT, Oh JM, Kim H. Potentially inappropriate prescriptions to older patients in emergency departments in South Korea: A retrospective study. Ther Clin Risk Manag 2021;17:173-81.
25. Chang CB, Lai HY, Hwang SJ, Yang SY, Wu RS, Liu HC, et al. Prescription of potentially inappropriate medication to older patients presenting to the emergency department: a nationally representative population study. Sci Rep 2018;8:11727. doi: 10.1038/s41598-018-30184-4.
26. Hamidah KF, Rahmadi M, Meutia F, Kriswidyatomo P, Rahman FS, Izzah Z, et al. Prevalence and factors associated with potentially inappropriate medication and medication complexity for older adults in the emergency department of a secondary teaching hospital in Indonesia. Pharm Pract (Granada) 2022;20:2735. doi: 10.18549/PharmPract.2022.4.2735.
27. Gardner K, Schwarz K, Pearson S, Jacknin G. Potentially inappropriate medication usage in older adults in a Tertiary Academic Medical Center Emergency Department. J Pharm Pract 2022;35:892-7.
28. Hwang S, Jun K, Ah YM, Han E, Chung JE, Lee JY. Impact of anticholinergic burden on emergency department visits among older adults in Korea: A national population cohort study. Arch Gerontol Geriatr 2019;85:103912. doi: 10.1016/j.archger.2019.103912.
29. Liang CK, Chou MY, Hsu YH, Wang YC, Liao MC, Chen MT, et al. The association of potentially inappropriate medications, polypharmacy and anticholinergic burden with readmission and emergency room revisit after discharge: A hospital-based retrospective cohort study. Br J Clin Pharmacol 2023;89:187-200.
30. Robertson SS, Mouksassi MS, Varin F. Population pharmacokinetic/pharmacodynamic modeling of O-Desmethyltramadol in young and elderly healthy volunteers. Drugs Aging 2019;36:747-58.
31. Bahardoust M, Mousavi S, Mozafari JK, Moezi ZD, Haghmoradi M, Ebrahimi P, et al. Association of tramadol use with risk of hip fractures in patients with osteoarthritis: A systematic review and meta-analysis of observational studies. Int J Orthop Trauma Nurs 2024;52:101078. doi: 10.1016/j.ijotn.2023.101078.
32. Virnes RE, Tiihonen M, Karttunen N, van Poelgeest EP, van der Velde N, Hartikainen S. Opioids and falls risk in older adults: A narrative review. Drugs Aging 2022;39:199-207.
33. Harmsze AM, de Boer A, Boot H, Deneer VH, Heringa M, Mol PG, et al. Interaction between clopidogrel and proton pump inhibitors. Ned Tijdschr Geneeskd 2011;155:A2442. PMID: 21771377.
34. Johnell K, Klarin I. The relationship between number of drugs and potential drug-drug interactions in the elderly: a study of over 600,000 elderly patients from the Swedish Prescribed Drug Register. Drug Saf 2007;30:911-8.
35. Sharma R, Bansal P, Garg R, Ranjan R, Kumar R, Arora M. Prevalence of potentially inappropriate medication and its correlates in elderly hospitalized patients: A cross-sectional study based on Beers criteria. J Family Community Med 2020;27:200-7.
36. Hammouda N, Hwang U. 1 Risk of emergency department revisit or hospitalization in older adults discharged with potentially inappropriate medications: A retrospective cohort study [abstract]. Ann Emerg Med 2019;74(4 Suppl):S1.