Prevalence and Risk Factors of Potentially Inappropriate Medication (PIM) Prescribing in Geriatrics: A Study Based on Beers Criteria 2019 at Hospital Kemaman Outpatient Pharmacy

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ABSTRACT

Introduction:
Potentially inappropriate medications (PIM) are drugs in which the risks of use in older adults outweigh the clinical benefits, particularly when safer and equally or more effective alternatives are available. Older adults especially geriatrics are more likely to experience multimorbidity and polypharmacy, increasing their risk of exposure to PIM. This study aimed to determine the prevalence of PIM prescribing among geriatric patients attending the outpatient pharmacy of Hospital Kemaman and to identify factors associated with PIM use based on the 2019 Beers Criteria.

Methods:
This cross-sectional study was conducted from January 2023 to August 2023. Patients aged 65 years and above who were under specialist clinic follow-up and had at least one prescribed medication at the outpatient pharmacy were recruited. Prescriptions of the patients meeting the inclusion criteria were reviewed for PIM. Descriptive statistics were employed to present the demographic and clinical data. Associated factors were assessed using multiple logistic regression with a *P*-value <0.05 considered statistically significant.

Results:
A total of 381 patients were included, of which 62.7% (n= 239) were male, and the majority (n= 308, 80.8%) were of Malay ethnicity. This study identified 181 (47.5%) instances of PIM, with the highest prevalence being PIM classified as 'use with caution in older adults' (33.9%). There was a significant association between polypharmacy and the presence of PIM. The most commonly prescribed PIM was frusemide (22.2%).

Conclusion:
This study revealed a high prevalence of PIM prescribing among geriatric patients at the outpatient pharmacy of Hospital Kemaman, which was significantly associated with polypharmacy. Greater emphasis should be given on improving the healthcare professionals' awareness on PIM prescribing in order to enhance medication safety among geriatric patients in outpatient settings.

Keywords:
Ageing, elderly, inappropriate prescribing, Beers Criteria

INTRODUCTION

The ageing population is increasing significantly worldwide and is projected to grow from approximately 12% in 2013 to over 20% by 2050. This demographic shift is expected to impose a substantial economic burden on healthcare systems and society. Consequently, healthcare systems worldwide must be adequately prepared to address these challenges, particularly in meeting the complex care needs of older patients.[1]

As we age, our bodies become weaker, and the risk of developing multimorbidity, defined as the presence of two or more chronic diseases increases. Multimorbidity is highly prevalent among older adults aged 65 years and above, with common conditions including diabetes mellitus, hypertension, renal impairment, and cardiovascular disease. These conditions often necessitate multiple pharmacological therapies, placing geriatric patients at a heightened risk of polypharmacy.[2] The incidence of adverse drug reactions (ADR) increases proportionally with the number of medications prescribed. Evidence suggests that older adults receiving four medications have a 38% increased risk of drug–drug interactions or ADRs, while those prescribed seven or more medications experience an 82% higher risk.[3] ADR among older adults may result in increased hospitalisation rates, prolonged hospital stays, and escalating healthcare costs. Studies have reported that ADR-related hospital admissions in geriatric patients account for approximately 6% to 12% of all admissions, with advanced age, polypharmacy, comorbidities, and the use of PIM identified as key risk factors. [4]

PIM are defined as drugs for which the risks of use outweigh the clinical benefits, particularly when safer or more effective therapeutic alternatives are available.[5] PIM prescribing among geriatric patients should be avoided as the potential harm of adverse drug outcomes increases as the pharmacokinetic and pharmacodynamic properties of certain drugs are greatly altered in older people.[6]

The Beers Criteria is one of the screening tools used to identify PIM use among geriatric patients. Since it was first developed in 2021, the list of PIM has been continuously updated to guide healthcare professionals in minimising the use of medications where potential harms outweigh benefits in geriatics, thereby reducing the incidence of ADR.[7]

To the best of our knowledge, limited studies in Malaysia have examined the prevalence of PIM prescribing and associated risk factors among geriatric patients in outpatient settings, despite the majority of older adults receiving care through outpatient services. A systematic review and meta-analysis conducted by Tian et al., which involved older participants from 17 countries, highlighted an increasing prevalence of PIM prescriptions in outpatient settings over the past two decades.[2] Similarly, another study conducted in a primary care unit in a hospital in Thailand demonstrated a high prevalence of PIM prescriptions among geriatric patients.[8] Locally, a recent inpatient study at Hospital Bentong, Pahang, revealed that 71.3% of geriatric patients received at least one PIM, with female sex and number of prescribed medications identified as the main risk factors.[9] Internationally, studies have reported a PIM prevalence of 74% among hospitalised older adults in India, compared with 39.9% in a tertiary hospital in Saudi Arabia.[10-11]

According to the Hospital Kemaman's 2020 and 2022 data, about 15-20% of patients attending the specialist clinic and receiving outpatient services were aged 60 years and above. This percentage is expected to increase in the coming years as the number of older populations increases worldwide.

Therefore, the objectives of this study were to identify the prevalence of PIM prescribing among geriatric patients at the outpatient pharmacy, Hospital Kemaman and to determine factors associated with PIM prescribing based on the American Geriatric Society (AGS) Beers Criteria 2019.

This study seeks to enhance awareness of PIM prescribing among healthcare professionals and subsequently improve medication safety for geriatric patients in outpatient settings.

METHODS

Study Design, Population and Setting

This cross-sectional study was conducted between January 2023 and August 2023 at the outpatient pharmacy of Hospital Kemaman. All geriatric patients aged 65 years and above who attended outpatient services at Hospital Kemaman and were prescribed at least one medication were included. Prescriptions meeting the inclusion criteria were reviewed to identify PIM.

Drug-related information, including medication name, strength, dosage form, frequency, duration of supply, route of administration, and total number of prescribed medications, was extracted from patients' prescriptions.

Additional clinical information relevant to PIM assessment—such as history of falls or fractures, gastric or duodenal ulcers, syncope, and comorbid conditions including urinary incontinence (all types) in women, benign prostatic hyperplasia, lower urinary tract symptoms, Parkinson's disease, renal impairment, delirium, dementia, and other cognitive impairments—was also documented.

Data Collection

Prior to data collection, all study personnel received training on the 2019 AGS Beers Criteria. Data were collected at the dispensing counter during medication dispensing.

Demographic information was obtained directly from patients, while clinical information was used to categorise PIM, particularly for medications classified under Category 2 of the Beers Criteria.

In this study, PIM prescribed to geriatric patients were classified into five categories based on the AGS Beers Criteria 2019, as described by Teng et al.[9] The five PIM categories and their respective descriptions are presented in Table 1. A single medication could meet the criteria for more than one PIM category depending on the patient's clinical condition; in such cases, the medication was classified under multiple categories.

Table 1: Categories of PIM adapted from AGS Beers Criteria 2019 by Teng et al.[9]

PIM Category	Descriptions
PIM 1	Medications that are potentially inappropriate in most older adults (to avoid)
PIM 2	Medications that are potentially inappropriate in older patients with specific diseases or syndromes, to avoid due to drug-disease or drug-syndrome interactions that may exacerbate the disease or syndrome
PIM 3	Medications to be used with caution in older adults
PIM 4	Medications to be avoided due to potentially important drug-drug interactions
PIM 5	Non-anti-infective medications that should be avoided or have their dosage reduced based on kidney function.

Notes: AGS=American Geriatric Society, PIM=Potentially Inappropriate Medication

Sample Size

The sample size was calculated using the estimation of proportion formula where number of sample required is calculated as $n = (Z(1-\alpha)/2/\Delta)^2 P(1-P)$ where $(Z(1-\alpha)/2 = 1.96$, level of confidence = 95%, $\alpha = 5\%$, population's proportion (P) = 0.55[7] and precision of estimate (Δ) = 0.05.[12] Based on this formula and current data, the recommended sample size was 381 individuals.

Statistical Analysis

The data was analysed using Statistical Package for Social Sciences (SPSS) software version 27. Demographic and clinical characteristics were presented as frequencies and percentages. Simple and multiple logistic regression analyses were performed to identify factors associated with PIM. Variables with a *P*-value <0.25 in the simple logistic regression were included in the multiple logistic regression. A forward likelihood ratio (LR) selection method was applied, followed by re-estimation using the enter method. Some variables were retained in the final model despite non-significance due to their clinical relevance. Multicollinearity and interaction terms were assessed. Hosmer-Lemeshow test, classification table and area under the receiver opening characteristic (ROC) curve were applied to check the model fit. A *P*-value <0.05 was considered statistically significant.

RESULTS

A total of 381 geriatric patients were reviewed and included in this study. Most of the patients were male (n=239, 62.7%), identified as Malay (n=308, 80.8%), aged 65–69 years old (n=152, 39.9%) with a mean age of 72.38±6.29 year and had comorbidities (n=256, 67.2%). Table 2 shows that nearly 60% of the patients were prescribed more than five medications per prescription, indicating the presence of polypharmacy. The highest number of medications prescribed to a single patient was 18.

Almost half of the patients (n=181, 47.5%) were prescribed with PIM. A higher proportion of females who received PIM (55.6%) was observed compared to those who did not (44.4%). The distribution of PIM use was largely similar across gender, ethnic and age groups, with male, Malay patients aged 65 – 69 years constituting the majority in both groups.

More than half of the patients (n=200, 52.5%) did not have PIM prescribed in their prescriptions. Among the patients prescribed with PIM, most of the patients (n=126, 33.0%) had one such medication prescribed to them. One patient was prescribed with 18 medications, of which 5 were found to be PIM. (Table 3)

Based on the AGM Beers Criteria, the category PIM 3 (n=129, 33.9%) contributed to the highest prevalence of PIM found among the patients followed by PIM 1 (n=56, 14.7%) and PIM 2 (n=41, 10.8%). (Table 4)

In this study, 35 medications were identified as PIM with frusemide (n=56, 22.2%) found to be most common, followed by aspirin (n=42, 16.7%) and tramadol (n=37, 14.7%). Table 5 shows the list of PIM prescribed to the patients included in the study.

Among all the associated factors of PIM prescribing, only polypharmacy showed a significant association (*P*<0.001). Patients with polypharmacy had 4.76 times higher odds of receiving a PIM compared to those without polypharmacy, after controlling for gender and the presence of comorbidities (Table 6).

Table 2: Demographic, clinical characteristics and distribution of patients with PIM (n=381)

Variables	n (%)		
	Total	Did not receive PIM	Received PIM
Gender			
Male	239 (62.7)	137 (57.3)	102 (42.7)
Female	142 (37.3)	63 (44.4)	79 (55.6)
Ethnicity			
Malay	308 (80.8)	161 (52.3)	147 (47.7)
Non-Malay	73 (19.2)	39 (53.4)	34 (46.6)
Age (years)			
65-69	152 (39.9)	82 (53.9)	70 (46.1)
70-74	110 (28.9)	57 (51.8)	53 (48.2)
75-79	67 (17.6)	34 (50.8)	33 (49.2)
≥80	52 (13.7)	27 (51.9)	25 (13.8)
Presence of polypharmacy (> 5 medications per prescription)			
Yes	220 (57.7)	81 (36.8)	139 (63.2)
No	161 (42.3)	119 (73.9)	42 (26.1)
Presence of comorbidity			
Yes	256 (67.2)	153 (59.8)	103 (40.2)
No	125 (32.8)	47 (37.6)	78 (62.4)

Note: PIM=Potentially Inappropriate Medication

Table 3. Number of PIM prescribed per patient (n=381)

Number of PIM prescribed per patient	n (%)	Average number of drugs per patient
0	200 (52.5)	4
1	126 (33.0)	6
2	43 (11.3)	8
3	9 (2.4)	11
4	2 (0.5)	13
5	1 (0.3)	18

Table 4: Prevalence of PIM by category based on the AGS Beers Criteria 2019 (n=262)

PIM Category	n (%)
PIM 1	56 (14.7)
PIM 2	41 (10.8)
PIM 3	129 (33.9)
PIM 4	18 (4.7)
PIM 5	18 (4.7)

Note: PIM = Potentially Inappropriate Medication

Table 5: PIM prescribed to the patients (n=252)

PIM	n (%)
Frusemide	56 (22.2)
Aspirin	42 (16.7)
Tramadol	37 (14.7)
Prazosin	16 (6.3)
Gabapentin	12 (4.8)
Pantoprazole	10 (3.9)
Chlorpheniramine	8 (3.2)
Colchicine	7 (2.8)
Lorazepam	6 (2.4)
Terazosin	5 (2.0)
Omeprazole	5 (2.0)
Diazepam	5 (2.0)
Alfuzosin	4 (1.6)
Quetiapine	4 (1.6)
Mirtazapine	3 (1.2)
Rivaroxaban	3 (1.2)
Diphenhydramine	3 (1.2)
Celecoxib	3 (1.2)
Clonazepam	2 (0.8)
Esomeprazole	2 (0.8)
Alprazolam	2 (0.8)
Spironolactone	2 (0.8)
Levetiracetam	2 (0.8)
Amitriptyline	2 (0.8)
Dabigatran	1 (0.4)
Hydrochlorothiazide	1 (0.4)
Escitalopram	1 (0.4)
Fluoxetine	1 (0.4)
Tamsulosin	1 (0.4)
Chlorpromazine	1 (0.4)
Benzhexol	1 (0.4)
Prochlorperazine	1 (0.4)
Pregabalin	1 (0.4)
Diazepam	1 (0.4)
Carbamazepine	1 (0.4)

Note: PIM=Potentially Inappropriate Medication

Table 6: Associated factors of PIM prescription by simple and multiple logistic regression models

Variables	Simple Logistic Regression			Multiple Logistic Regression		
	b	Crude OR (95% CI)	*P*-value	Adj.b	Adjusted OR (95% CI)	*P*-value
Gender						
Male	1 (ref.)	1.684 (1.108-2.560)	0.015	1(ref.)	1.364 (0.865-2.151)	0.181
Female	0.521			0.310		
Age	0.014	1.014 (0.982-1.047)	0.389	-	-	-
Ethnicity						
Malay	1 (ref.)	0.955 (0.573-1.592)	0.859	-	-	-
Non-Malay	-0.046					

Table 6. Continued

Variables	Simple Logistic Regression			Multiple Logistic Regression		
	b	Crude OR (95% CI)	*P*-value	Adj.b	Adjusted OR (95% CI)	*P*-value
Presence of polypharmacy						
Yes	1 (ref.)	5.399 (3.438-8.478)	<0.001	1(ref.)	4.757 (2.986-7.577)	<0.001
No	1.686			1.560		
Presence of comorbidity						
Yes	1 (ref.)	2.119 (1.363-3.296)	<0.001	1(ref.)	1.477 (0.909-2.398)	0.115
No	0.751			0.390		

Notes: [a]PIM=Potentially Inappropriate Medicines, [b]OR=Odd Ratio

[c]Forward LR Multiple Logistic Regression model was applied. Multicollinearity and interaction terms were checked and found not significant. Hosmer-Lemeshow test (p=0.774), classification table (overall correctly classified percentage= 68.8%) and area under the receiver opening characteristic (ROC) curve (71.8%) were applied to check the model fit

DISCUSSION

The study found that PIM was commonly prescribed among geriatric patients at the Hospital Kemaman outpatient pharmacy (47.5%). Similarly, the global pooled prevalence of PIM prescribing in older adults was reported at 36.7%, with higher rates in Africa (47.0%) followed by South America (46.9%), Asia (37.2%), Europe (35.0%), North America (29.0%), and Oceania (23.6%).[2]

The AGS Beers Criteria 2019 contained a more comprehensive and updated list compared to previous versions published in 2012 and 2015. The latest version included the addition of new medications, specific drug-drug interactions-such as warfarin and ciprofloxacin-, expanded guidance on kidney function and disease-specific conditions, as well as "use with caution" drugs.[7] This has contributed to the high prevalence reported in the study as more medications were identified as PIM.

Frusemide (22.2%) was the most commonly prescribed PIM found in the study. Interestingly, a study conducted in Hospital Sungai Siput, Perak has identified frusemide as one of the most commonly prescribed PIM, aside from other drugs such as perindopril, amlodipine, hydrochlorothiazide and prazosin.[13] Similarly, diuretics such as frusemide was also found to be the most commonly prescribed PIM in a study at a primary care setting in Thailand.[8] Frusemide is a loop diuretic which is commonly prescribed to reduce water retention as well as an antihypertensive agent in patients with congestive heart failure, liver cirrhosis, or renal disease. In Hospital Kemaman, the prescribing of frusemide were aimed at reducing water retention in patients with renal and congestive heart failure which has contributed to the high prevalence of frusemide prescribing. Although prescribing frusemide might not be the absolute wrong option, prescribing alternatives especially in geriatric patients might be more useful and safer.

Another frequently prescribed PIM found in this study was aspirin (16.7%), a salicylate used to treat pain, fever, inflammation, migraines, and reduce the risk of major adverse cardiovascular events. According to the AGS Beers Criteria 2019, when aspirin is indicated for the primary prevention of cardiovascular disease, it falls under PIM category 3, which is to be used with caution in geriatrics aged 70 years and above. [7]

Tramadol (14.7%) was found to be third most commoly prescribed PIM in the study. Tramadol is commonly prescribed because it is associated with lower risk of stomach ulcers and internal bleeding, adverse reactions commonly associated with the use of non-steroidal anti-inflammatory drugs (NSAIDS). A study reported that pain specialists in Southeast Asia preferred tramadol due to its efficacy, tolerability and safety profile which make it appropriate for use in elderly patients, outpatients, and for long-term treatment.[14] However, its use warrants close sodium level monitoring when starting or changing dosages in older adults.

The findings by Alhawassi et al. who reported a higher prevalence of PIM in female patients were in line with our study, where more than half of the female patients (55.6%) received PIM.[11] Similarly, a study in Saudi Arabia which examined gender-based variations in PIM prescribing among older adults, had also found PIM to be more common in women than men and suggested it to be due to socioeconomic differences.[15] In our study, the majority of PIM identified in male patients involved non-selective peripheral alpha-1 blockers for benign prostatic hyperplasia (e.g terazosin and alfuzosin), aspirin for primary cardiovascular prevention and diuretics (e.g. frusemide) for hypertension, cardiovascular disease, and chronic kidney disease.

Our study found polypharmacy to be significantly associated with PIM prescribing which was consistent with a study from Seoul Teaching Hospital.[16] The risk of PIM, across all Beers Criteria categories, increased proportionally with the number of medications prescribed, suggesting that the high medication burden from managing multiple comorbidities in geriatric patients directly contributes to the risk of receiving PIM.

Avoiding PIM by selecting safer alternatives can reduce adverse drug events, emergency department visits, and associated healthcare costs for geriatric patients.[8] Implementing clinical decision support, such as standardised lists of drug-drug interactions, could guide clinicians in minimising PIM prescribing especially in geriatrics. Continuous education programs on PIM are vital to improve prescribing practices and improve medication safety. Enhanced vigilance and a deeper understanding of age-related physiological changes, pharmacokinetics and PIM

risks are essential to prevent iatrogenic harm in this vulnerable population.

Limitations

This study had several limitations. First, as a single-centre study, the findings may not be generalisable to the prevalence of PIM prescribing among geriatric patients in Malaysia. In addition, the Beers Criteria were developed based on the American population, while the European Union (EU) PIM criteria were derived primarily from Caucasian populations. Therefore, the applicability and clinical effects of these medications may differ in Asian populations, including Malaysians.

CONCLUSION

The prescribing of PIM among geriatric patients in the outpatient settings of Hospital Kemaman was found to be common and significantly associated with polypharmacy. Efforts to increase the awareness of healthcare professionals on PIM-related risk must be strengthened. Continuous education on PIM and the implementation of clinical decision support will be beneficial in improving prescribing practices and medication safety especially in this vulnerable population.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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ETHICAL APPROVAL

Our study was registered with the National Medical Research Register (NMRR-22-01912-3N7) and approved by the Medical Research and Ethics Committee (MREC), Malaysia.

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