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Exploring Potentially Inappropriate Medication Use on Elderly Patients in a General Medicine Ward Using 2023 AGS Beers Criteria

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ABSTRACT

Objectives: Potentially inappropriate medication (PIM) use is a significant concern among the elderly, a vulnerable population, due to physiological changes, and the risk of multiple comorbidities and polypharmacy. This study aimed to assess the use of PIM among elderly inpatients in tertiary care hospital in eastern Nepal.

Methods: A three-month prospective observational study was conducted, involving 200 eligible elderly patients admitted to general medicine ward. Relevant data were collected from patient case sheets, nursing and doctor cardex, discharge summaries, and via patient interviews. PIMs were identified based on the latest 2023 AGS Beers Criteria.

Results: Among the 200 eligible patients, 108 (54.0%) were prescribed at least one PIM. Medications that should be avoided in older patients accounted for 32.2%, where prazosin and hyoscine were the most common. Additionally, 52.8% of the medications required cautious use, with diuretics being the most frequent one. Multivariate analysis revealed that patients with chronic kidney disease (CKD) and the number of prescribed medicines significantly influenced the likelihood of PIMs with an adjusted odd ratio of 6.730 (2.111–21.456) and 2.764 (1.448–5.276), respectively, at $p < 0.05$.

Conclusion: PIMs are more common among the elderly, with CKD and polypharmacy contributing significantly to their prevalence. To reduce PIM use, healthcare professionals, including clinical pharmacists, should implement targeted interventions, particularly for older adults with CKD who are managing with multiple medications.

1 | Introduction

The global population is aging rapidly, with aging-related disorders becoming increasingly prevalent [1]. Conditions such as cardiovascular diseases, neoplasms, chronic respiratory illnesses, and sensory impairments associated with multimorbidity account for 51.3% of the global disease burden among older adults [2]. In Nepal, this demographic shift is particularly noticeable. The 2021 census indicates that the elderly population in Nepal has increased by 38.2% since 2011, with 2.97 million individuals now aged 65 years or older, representing 10.21% of the total population [3]. This demographic change has significant implications for healthcare, particularly regarding medication use in the elderly.

Elderly patients, mainly those aged 65 years or older, are more likely to experience polypharmacy—a condition characterized by the use of multiple medications—due to the high prevalence of chronic diseases, comorbidities, disabilities, and dependency among this age group [4]. Prescribing for multimorbid elderly

patients requires a careful balance between optimizing chronic disease management and minimizing the risks associated with potentially inappropriate medications (PIMs). PIMs are defined as medications that may cause more harm than benefit [5].

The choice of medications in this population is crucial, as inappropriate prescribing can lead to adverse drug reactions (ADRs). ADRs in older adults are associated with an increase in emergency department visits, hospitalizations, healthcare costs, and higher morbidity and mortality rates [6, 7]. Elderly patients admitted to medical wards face an even higher risk of PIMs due to advanced age, chronic comorbidities, polypharmacy, renal impairment, and frequent changes in drug treatment [8–10]. These PIMs can have significant consequences, including emergency department admission, extended hospitalizations, long-term care admissions, and higher healthcare expenses.

Several tools, including the Beers Criteria, Medication Appropriateness Index (MAI), and STOPP/START Criteria, are available to identify PIMs in elderly patients [11]. Among these, the American Geriatrics Society (AGS) Beers Criteria is particularly effective in reducing drug-related adverse events, emergency visits, and hospitalizations while improving overall patient outcomes. The 2023 update to the Beers Criteria introduces significant changes, providing a more systematic and scientific approach to identifying PIMs [12].

In developing countries like Nepal, prescribing patterns are often suboptimal, contributing to a significant burden of medication errors and drug-related problems (DRPs) [13–15]. A recent study in Nepal revealed that 77.4% of inpatients experienced at least one DRP, underscoring the gravity of the issue [15]. Consistently, studies have reported irrational prescribing practices in the country, including low adherence to WHO prescribing indicators, frequent prescription errors, over-prescription, and underutilization of generic medicines [14]. Moreover, there is limited awareness about medication errors among health professionals in Nepal [16]. These practices and limited awareness, combined with an increasing elderly population suggest a high prevalence of PIMs use in Nepal. Addressing these issues through PIMs detection is critical to improving patient safety, reducing healthcare costs, and promoting rational prescribing practices in the country.

A 2023 meta-analysis indicated that the global prevalence of PIM use among older people is roughly 36.7%, with elevated rates noted in low-income nations relative to high-income countries [17]. In developing nations, the incidence is approximately 33.3%, with significant prevalence in Africa (47.0%) and South America (46.9%) [17]. Despite the growing elderly population in Nepal, studies on PIMs among this group are limited. Only a few studies have been conducted using older versions of the Beers Criteria, and no studies have been performed utilizing the 2023 Beers Criteria. Research conducted by using a previous version of Beers and other tools has indicated varying prevalence in Nepal: a study in Bharatpur revealed that 26.3% of elderly patients received at least one PIM [18], but another study in Biratnagar showed that 14% of prescriptions were deemed inappropriate [19]. This study addresses this gap by evaluating PIMs among elderly patients admitted to the General Medicine Ward of Koshi Hospital, Biratnagar, using the 2023 AGS Beers Criteria. As the first prospective observational study in this region, it aimed to identify PIMs, assess their prevalence, and explore their potential predictors. Our research findings could lead to the formulation of targeted interventions to reduce PIMs, ultimately improving medication safety and patient outcomes in Nepal's aging population.

2 | Method

2.1 | Study Design and Setting

A prospective observational study was conducted at the general medicine ward of Koshi Hospital in Biratnagar, Nepal, from January 2024 to April 2024. Koshi Hospital, a 350-bed governmental tertiary care hospital in Morang District, Eastern Nepal, serves a diverse patient population from both rural and urban areas, offering specialized medical services across various departments and treating approximately 1000–1200 patients daily [20].

2.2 | Study Participants, Sample Size, and Sampling Technique

The study participants were hospitalized patients aged 65 or higher, who were admitted to the General Medicine ward and were undergoing treatment during the study duration. Exclusion criteria included patients with incomplete medical records or case sheets, those who refused to participate, patients undergoing treatment for less than one day, those in the end stage of their disease receiving only palliative care, patients who left against medical advice, and those who died or were transferred to other hospitals.

The sample size was determined using a formula based on the prevalence [21]. A prevalence of 14%, as reported in a study by Saibijaya Rijal et al. [19], was used for the calculations. Considering a 95% confidence interval and a 5% margin of error, 185 samples were calculated. However, in order to increase the power of the study, all eligible patients admitted in 3-month duration were enrolled.

2.3 | Procedure

We developed and pretested data collection form to record participants' demographic data and medical details to identify PIMs and their potential predictors. We recorded participants' age, gender, Body Mass Index (BMI), duration of hospitalization, and medical history (including past medical, medication, family, social, drug, and nondrug allergies). Similarly, results of routine laboratory tests, provisional and final diagnoses, prescription medications used during hospitalization and at discharge (including the generic name of the drug, dose, dosage form, frequency, route of administration, and duration of use), and follow-up notes were recorded and continuously updated in the data collection form. All relevant data were collected from patient case sheets, medical charts, physician ward rounds, patient interviews, and the discharge summary form. We employed the Cockcroft–Gault equation to evaluate PIM under the Beers criteria to calculate creatinine clearance (CrCl) [22]. Medications of older patients were assessed for PIMs using the 2023 Beers criteria [12]. Following the 2023 Beers Criteria, PIMs were categorized into

TABLE 1 | Sociodemographic and clinical-related characteristics of the hospitalized elderly patients ($n = 200$).

Category	Frequency	Percentage (%)
Gender wise distribution		
Male	85	42.50%
Female	115	57.50%
Age-wise distribution of elderly patient		
Age Group (Years)		
(Mean age ± SD)	(71.80 ± 6.42)	
65–74	136	68.0%
≥ 75	64	32.0%
Ethnic group of elderly patient		
Brahmin/Chhetri	54	27.0%
Madhesi	72	36.0%
Janajati	54	27.0%
Dalit	11	5.5%
Muslim	09	4.5%
Education status-wise distribution		
Primary	23	11.5%
Secondary	14	7.0%
Higher Secondary	05	2.5%
Bachelor & above	02	1.0%
No formal education	156	78.0%
Alcohol drinking distribution		
Never	126	63.0%
Previous	49	24.5%
Current	25	12.5%
Cigarette smoking distribution		
Never	61	30.5%
Previous	95	47.5%
Current	44	22.0%
Tobacco wise distribution		
Never	122	61.0%
Previous	47	23.5%
Current	31	15.5%
Enrolment in health insurance distribution		
Yes	137	68.5%
No	63	31.5%
Cohabitation wise distribution		
Living with spouse & children	119	59.5%
Living with spouse	08	4.0%
Living with children	63	31.5%
Living alone	10	5.0%
BMI, kg/m^2 wise distribution		
Underweight (< 18.5)	38	19.0%
Normal (18.5 to < 25)	121	60.5%
Overweight (25.0 to < 30)	35	17.5%
Obesity (> 30)	06	3.0%
No. of chronic disease		
None	16	8.0%
1 disease	62	31.0%
2 diseases or above	122	61.0%
Multimorbidity		
Yes	122	61.0%
No	78	39.0%
CCI score		
Mild	11	5.5%
Moderate	121	60.5%
Severe	68	34.0%
No. of drugs prescribed		
(Mean age ± SD)	(12.35 ± 3.96)	
> 12	96	48.0%
≤ 12	104	52.0%
Hospital stays (Day)		
(Mean age ± SD)	(7.09 ± 3.29)	
Long stay (> 7 days)	69	34.5%
Short stay (≤ 7 days)	131	65.5%

Note: Multimorbidity: Two or more chronic disease conditions.

- i) medications considered potentially inappropriate, ii) medications that are potentially inappropriate in patients with specific diseases or syndromes, iii) medications to be used with caution, iv) potentially inappropriate drug–drug interactions, and v) medications that need dose adjustment based on kidney function [12]. We thoroughly reviewed all the data once the initial screening was completed, and an independent clinical pharmacist validated the identified PIMs. Each PIMs was then documented.

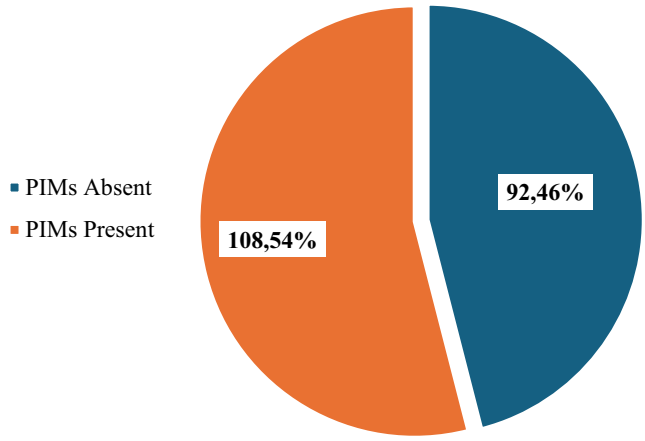

FIGURE 1 | Prevalence of PIMs in hospitalized elderly patients.

2.4 | Statistical Analysis and Software Used

All the data collected were entered into MS Excel and then imported into the Statistical Package for Social Sciences (SPSS) version 27.0 for analysis. Descriptive and analytical statistics were used to analyze the data. The mean and standard deviation (SD) were recorded for continuous variables and percentages for categorical variables.

The presence of PIM use, as defined in the five categories of AGS Beers criteria, was taken as the outcome variable. It, was treated as a binary variable (1 = Yes, 2 = No) for the purpose of logistic regression analysis. Binary logistic regression analysis was used to determine the influence of predictor variables on the occurrence of PIMs. Those significant variables at $p < 0.05$ in univariate analysis were incorporated in multivariate logistic regression mode to assess their independent effects. A p-value < 0.05 was considered significant in multivariate logistic regression.

3 | Results

3.1 | Characteristics of Enrolled Patients

A total of 200 patients enrolled in this study. Among them, most elderly patients were female (57.5%), aged 65–74 (68.0%) with an average age of 71.80 ± 6.42 years. Most participants (92%) reported having one or more chronic diseases. The Charlson Comorbidity Index (CCI) scores, which measure the severity of comorbidities, revealed that 34.0% had severe comorbidities. Regarding medication, the mean number of drugs prescribed was 12.35 (± 3.96) from admission to discharge. The average hospital stay was 7.09 days. Detailed sociodemographic and clinical characteristics are presented in Table 1.

3.2 | PIMs Use for the Elderly Based on 2023 AGS Beers Criteria

Out of a total of 2466 prescribed drugs, 180 (7.30%) were identified as PIMs. More than half of the patients (54%) had at least one PIM (Figure 1). Among these patients, 59 (29.5%) had one PIM, 32 (16.0%) had two, 11 (5.5%) had three, and 6 (3.0%) had four.

Among 180 identified PIMs, 32.2% of the PIMs fall under the category of medicine considered as potentially inappropriate, whereas Prazosin and Scopolamine (Hyoscine) (10 PIMs, 17.24%) account for the highest rank. Medications potentially inappropriate in patients with certain diseases or syndromes constitute six PIMs (3.3%). More than half of PIMs (52.8%) were medications that must be used cautiously. Diuretics were the most prevalent in this category, accounting for 75 PIMs (78.95%), followed by tramadol with 12 PIMs (12.63%). Potentially inappropriate drug–drug interactions were identified in three PIMs (1.7%), involving combinations of nonselective peripheral alpha-1 blockers with loop diuretics. Lastly, medications whose dosages should be adjusted based on renal function make up 10% of total PIMs ($n = 18$). Spironolactone leads this category with nine PIMs (50%) and Levetiracetam with three PIMs (16.67%). Table 2 provides the details of PIMs and the recommendation of 2023 AGS Beers Criteria with quality of evidence and strength of recommendation.

3.3 | Binary Logistic Regression Analysis Between Selected Predictor Variables With PIMs

The prevalence and risk of PIMs were significantly greater in Multimorbidity, hospital stay, number of prescribed medicines, and patients with CKD ($p < 0.05$). Furthermore, multivariate binary logistic regression analysis showed that the number of prescribed medicines and patients with CKD had a higher risk of experiencing PIMs, with an adjusted odds ratio of 2.764 (1.448–5.276) and 6.730 (2.111–21.456), respectively at p-value < 0.05. The results of the bivariate and multivariate logistic regression analysis of demographic and clinical characteristics are shown in Table 3.

4 | Discussion

This study highlights a significant occurrence of PIMs among elderly patients in a tertiary care hospital in Eastern Nepal. A notable finding was that 57.5% of participants were female, which mirrors the demographic trends of the elderly population in Nepal [23]. The average number of prescribed medications in our study was 12.35 ± 3.96, which reflects the high burden of comorbidities among the elderly, often leading to polypharmacy [24]. This aligns with the observation that three-fifths of the participants had two or more comorbidities, necessitating the use of multiple medications [24].

The prevalence of PIMs in our study was 54.0%, substantially higher than the rates reported in other hospitals in Nepal, such as Chitwan Medical College (34.67%) in 2019 and Koshi Hospital in 2016 (14%) [19, 25]. This variation could be due to differences in study design, patient populations, study period, and the version of the Beers Criteria used. Our study utilized the 2023 AGS Beers Criteria, which introduced modifications that may have contributed to the higher prevalence of PIMs in our study. This highlights the significant impact of guideline updates in identifying PIMs. Internationally, the prevalence of PIMs in our study is within a range reported by other studies, with a systematic

TABLE 2 | Prescribed PIMs with recommendation and rationale according to the 2023 AGS Beers Criteria.

PIMs medicine details (Frequency, %)	Recommendation, rationale, quality of evidence (QE), strength of recommendation (SR)
Category 1. Medications considered as potentially inappropriate in older adults (58, 32.2%)	
Cyproheptadine (1, 1.72%) Promethazine (1, 1.72%)	**Avoid**, Highly anticholinergic; clearance is reduced with advanced age, risk of confusion, dry mouth, constipation, and other anticholinergic effects or toxicity, QE = Moderate, SR = Strong
Aspirin for primary prevention of CVD (4, 6.90%)	**Avoid initiating for primary prevention of CVD. Consider deprescribing in older adults who are already taking it for primary prevention**, Studies suggest a lack of net benefit and potential for net harm when initiated for primary prevention in older adults. Note: It is generally indicated for secondary prevention in older adults with established CVD, QE = High, SR = Strong
Prazosin (10, 17.24%)	**Avoid use as an antihypertensive**, High risk of orthostatic hypotension & associated harms, especially in older adults; not recommended as routine treatment for hypertension; alternative agents have superior risk/benefit profile, QE = Moderate, SR = Strong
Amiodarone (1, 1.72%)	**Avoid first-line therapy for atrial fibrillation unless the patient has heart failure or substantial left ventricular hypertrophy**, Effective for maintaining sinus rhythm but has greater toxicities than other antiarrhythmics used in atrial fibrillation, QE = High, SR = Strong
Amitriptyline (1, 1.72%)	**Avoid**, Highly anticholinergic, sedating, and cause orthostatic hypotension, QE = High, SR = Strong
Aripiprazole (1, 1.72%) Haloperidol (1, 1.72%) Risperidone (1, 1.72%)	**Avoid**, Increased risk of stroke and greater rate of cognitive decline and mortality in persons with dementia, QE Moderate, SR = Strong
Clonazepam (3, 5.17%) Lorazepam (1, 1.72%) Midazolam (1, 1.72%)	**Avoiding all benzodiazepines increases**, the risk of cognitive impairment, delirium, falls, fractures, and motor vehicle crashes in older adults, QE = Moderate, SR = Strong
Zolpidem (1, 1.72%)	**Avoid**, ("Z-drugs") adverse events like those of benzodiazepines in older adults, with minimal improvement in sleep latency and duration, QE = Moderate, SR = Strong
Insulin, sliding scale (1, 1.72%)	**Avoid**, higher risks of hypoglycemia without improvement in hyperglycemia management, regardless of the care setting. Avoid insulin regimens that include only short- or rapid-acting insulin dosed according to current blood glucose levels without concurrent use of basal or long-acting insulin, QE = Moderate, SR = Strong

(Continues)

TABLE 2 | (Continued)

PIMs medicine details (Frequency, %)	Recommendation, rationale, quality of evidence (QE), strength of recommendation (SR)
Gliclazide (7, 12.07%) Glimepiride (2, 3.45%)	**Avoid sulfonylureas as first- or second-line monotherapy**, Increased risk of hypoglycemia, cardiovascular events, and all-cause mortality may increase the risk of cardiovascular death and ischemic stroke. QE = Hypoglycemia: High. CV events and all-cause mortality: Moderate. CV death and ischemic stroke: Low; SR = Strong
Metoclopramide (2, 3.45%)	**Avoid unless for gastroparesis, with a duration of use not exceeding 12 weeks**. It can cause extrapyramidal effects; the risk may be greater in frail older adults and with prolonged exposure. QE = Moderate; SR = Strong
Atropine (1, 1.72%) Scopolamine (Hyoscine) (10, 17.24%)	**Avoid** Highly anticholinergic, uncertain effectiveness. QE = Moderate; SR = Strong
Ketorolac (oral & parenteral) (7, 12.07%)	**Avoid** Increased risk of GI bleeding/peptic ulcer disease and AKI in older adults. QE = Moderate; SR = Strong
Chlorzoxazone (1, 1.72%)	**Avoid** use in elderly patients for Musculoskeletal complaints as skeletal muscle relaxants are poorly tolerated, their anticholinergic adverse effects cause sedation and increased risk of fractures; QE = Moderate; SR = Strong
Category 2. Potentially inappropriate medications to avoid in older adults with certain diseases or syndromes (6, 3.3%)	
Heart failure – Diltiazem (1, 16.67%) Heart failure—NSAIDs, COX-2 Inhibitors (2, 33.33%)	**Avoid** Potential to promote fluid retention and/or exacerbate heart failure (NSAIDs and COX-2 inhibitors, nondihydropyridine CCBs, thiazolidinediones) QE = COX-2 inhibitors: Low, NSAIDs: Moderate. SR = Strong
History of gastric or duodenal ulcer-Aspirin, Non-cox-2 selective NSAIDs (2, 33.33%)	**Avoid** May exacerbate existing ulcers or cause new/additional ulcers QE = Moderate; SR = Strong
Delirium—Antipsychotics (1, 16.67%)	**Avoid** because of adverse CNS effects
Category 3. Medications to be used with caution in older adults (95, 52.8%)	
Diuretics (75, 78.95%) Tramadol (12, 12.63%)	**Use with caution**. It may exacerbate or cause SIADH or hyponatremia; monitor sodium levels closely when starting or changing dosages in older adults. QE = Moderate; SR = Strong
Dapagliflozin (3, 3.16%) Empagliflozin (5, 5.26%)	**Use with caution. Monitor patients for urogenital infections and ketoacidosis**. Older adults may be at increased risk of urogenital infections, particularly women, in the first month of treatment. An increased risk of euglycemic diabetic ketoacidosis has also been seen in older adults. QE = Moderate; SR = Weak

(Continues)

TABLE 2 | (Continued)

PIMs medicine details (Frequency, %)	Recommendation, rationale, quality of evidence (QE), strength of recommendation (SR)
Category 4. Potentially inappropriate Drug–Drug Interaction to avoid in older adults (3, 1.7%)	
Nonselective peripheral alpha-1 blockers – Loop diuretics (Prazosin—Furosemide, torsemide) (3, 1.7%)	**Avoid in older women unless conditions warrant both drugs**. Increased risk of urinary incontinence in older women. QE = Moderate; SR = Strong
Category 5. Medications whose dosages should be adjusted based on renal function (18, 10%)	
Ciprofloxacin (1, 5.56%)	**Dosages used to treat common infections typically require reduction when CrCl < 30 mL/min**. Increased risk of CNS effects (e.g., seizures, confusion) and tendon rupture. QE = Moderate; SR = Strong
Nitrofurantoin (1, 5.56%)	**Avoid if CrCl < 30 mL/min**. Potential for pulmonary toxicity, hepatoxicity, and peripheral neuropathy, especially with long-term use. QE = Low; SR = Strong
Enoxaparin (1, 5.56%)	**Reduce dose** Increased risk of bleeding QE = Moderate; SR = Strong
Rivaroxaban (1, 5.56%)	Avoid if CrCl < 15 mL/min. Reduce the dose if CrCl is 15–50 mL/min following manufacturer dosing recommendations based on indication-specific dosing. Lack of efficacy or safety evidence in people with CrCl < 15 mL/min; limited evidence for CrCl 15–30 mL/min. QE = Moderate; SR = Strong
Spironolactone (9, 50.00%)	**Avoid**, Hyperkalemia, QE = Moderate; SR = Strong
Levetiracetam (3, 16.67%)	**Reduce dose**, CNS adverse effects, QE = Moderate; SR = Strong
Tramadol (1, 5.56%)	**Immediate release: reduce Dose**, CNS adverse effects, QE = Low; SR = Weak
Pregabalin (1, 5.56%)	**Reduce dose**, CNS adverse effects QE = Moderate; SR = Strong

Note: Total PIMs (180, 100%).

TABLE 3 | Binary logistic regression analysis between selected predictor variables and PIMs.

		PIMs use frequency		Bivariable analysis		Multivariable analysis	
Variables	**Category**	**Yes ($n=108$)**	**No ($n=92$)**	**COR (95% CI)**	***p***	**AOR (95% CI)**	***p***
Sex	Male	48 (44.4%)	37 (40.2%)	1.189 (0.677–2.090)	0.547		
	Female	60 (55.6%)	55 (59.8%)	1			
Age group	≥75	35 (32.4%)	29 (31.5%)	1.042 (0.574–1.891)	0.894		
	65–74	73 (67.6%)	63 (68.5%)	1			
Multimorbidity	Yes	74 (68.5%)	48 (52.2%)	1.995 (1.121–3.551)	**0.018***	1.027 (0.532–1.983)	0.936
	No	34 (31.5%)	44 (56.4%)	1			
No. of medication	>12	66 (61.1%)	30 (32.6%)	3.248 (1.813–5.817)	**<0.001***	2.764 (1.448–5.276)	**0.002***
	≤12	42 (38.9)	62 (67.4%)	1		1	
LoHS	>7	48 (44.4%)	21 (22.8%)	2.705 (1.459–5.015)	**0.001***	1.943 (0.993–3.803)	0.053
	≤7	60 (55.6%)	71 (77.2%)	1		1	
HTN	Yes	32 (29.6%)	22 (23.9%)	1.340 (0.712–2.522)	0.364		
	No	76 (70.4)	70 (76.1%)	1			
DM II	Yes	32 (29.6%)	23 (25.0%)	1.263 (0.675–2.365)	0.465		
	No	76 (70.4%)	69 (75.0%)	1			
CKD	Yes	27 (25.0%)	4 (4.3%)	7.333 (2.459–21.868)	**<0.001***	6.730 (2.111–21.456)	**0.001***
	No	81 (75.0%)	88 (95.7%)	1		1	
COPD	Yes	28 (25.9%)	35 (38.0%)	0.570 (0.312–1.041)	0.066		
	No	80 (74.1%)	57 (62.0%)	1			

Abbreviations: AOR, Adjusted odds ratio; CI, Confidence Interval; COR, Crude odds ratio; LoHS, Length of hospital stay.
*Shows significant at *p*-value 0.05.

review showing PIM rates ranging from 20.6% to 80.5% in inpatient settings [26].

A significant proportion (32.2%) of the medications in our study were inappropriate and should be in the avoid category. Prazosin and hyoscine butylbromide were the most commonly prescribed PIMs, consistent with the findings from a study conducted in Palestine [27]. Alpha-blockers like prazosin, often prescribed for hypertension, should be avoided in elderly patients due to their potential to cause orthostatic hypotension, which increases the risk of falls and fractures [28]. Long-acting sulfonylureas were also frequently prescribed, particularly among diabetic patients, despite their association with a high risk of severe hypoglycaemia in the elderly [12, 29]. This underscores the need for healthcare providers to consider safer alternatives for managing chronic conditions in elderly patients.

Additionally, 52.8% of the medications in our study were identified as needing to be used with caution in older adults, with diuretics being the most prescribed. Diuretics, while often necessary for managing cardiovascular and renal conditions, should be used at the lowest effective dose in elderly patients due to the risk of complications such as hyponatremia, fractures, and hyperkalaemia [30–33]. This finding aligns with the study conducted in Saudi Arabia in 2024, which has shown that diuretics are frequently prescribed PIMs that require careful monitoring [34].

In our study, nonselective peripheral alpha-1 blockers (e.g., prazosin) and loop diuretics (e.g., furosemide and torsemide) accounted for a small percentage (1.7%) of drug–drug interactions (DDIs). However, according to the Beers criteria, these combinations should be avoided in older adults due to their significant risk of urinary incontinence [12]. This finding is particularly relevant in the context of Nepal, where a recent study reported that 60.13% of patients experienced one or more potential DDIs [35]. Polypharmacy, a common phenomenon in the elderly population, exacerbates the likelihood of such interactions. Studies have consistently demonstrated that in individuals aged 75 years and older, the odds of clinically significant category D interactions increase exponentially with the number of dispensed medications [36]. Many of these potential DDIs are clinically relevant, often resulting in adverse drug reactions (ADRs) that contribute to increased morbidity and, in severe cases, mortality [37]. These findings underscore the importance of rational prescribing practices and vigilant medication review in elderly patients to mitigate the risks associated with PIMs and their interactions.

Our study did not find multimorbidity or hospital stay duration to be statistically significant predictors of PIMs in the multivariate analysis. However, chronic kidney disease (CKD) and the number of medications were found to statistically influence the occurrence of PIMs in older adults [38]. These results are

consistent with the 2011 systematic review that has demonstrated a correlation between the number of prescribed medications and the occurrence of PIMs [39]. Interestingly, our study found no significant association between PIM use and factors such as age or gender, which have been a topic of mixed findings in previous research [40–42].

Pharmacists play a crucial role in mitigating the risks associated with PIMs by reviewing medication regimens, assessing appropriateness, and discontinuing unnecessary medications. Their involvement is essential in improving the safety and efficacy of pharmacotherapy in elderly patients [43]. Further research is needed to understand the mechanism of PIM risk, particularly in CKD and higher hospital stays, to develop realistic interventions to improve appropriate medication utilization in elderly populations. However, this study underscores the need for continuous education and interventions targeting healthcare providers to enhance the safety of medication prescribing practices for the elderly.

5 | Strengths and Limitation

This is the first prospective observational study documenting the current utilization of PIMs among the elderly population of eastern Nepal following the 2023 Beers Criteria guidelines. By employing the latest version of PIM assessment tools, our study provides comprehensive insights into PIM prescriptions. However, our study has certain limitations. The generalizability of our results is limited due to the focus on a single center, restricting the applicability of findings both nationally and internationally. Additionally, the study was confined to the medicine ward, preventing broad extrapolation of results to other hospital departments. These limitations necessitate caution when interpreting the wider implications of our study.

6 | Conclusion

The study found that more than half of the older patients were prescribed one or more PIMs during hospitalization to discharge. The study also found a significant association between PIMs and the number of prescribed medicines and chronic kidney disease (CKD), highlighting the complexity of medication management in elderly populations. Specifically, medications categorized as "Medications to be used with caution" accounted for half of the identified PIMs. Prazosin and Hyoscine butyl bromide were the most frequently cited in the "Avoid" category. To reduce the use of PIMs, healthcare professionals, including clinical pharmacists, should implement targeted interventions for older adults, particularly those with CKD with polypharmacy.

Author Contributions

Subash Karki: conceptualization, investigation, methodology, data curation, analysis, validation, visualization, writing – original draft, writing – review and editing. **Rahi Bikram Thapa:** data curation, formal analysis, investigation, methodology, validation, writing – review and editing. **Rajeev Shrestha:** conceptualization, methodology, supervision, validation, visualization, writing – review and editing.

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Ethics Statement

Ethical approval for this study was obtained from the Institutional Review Committee, Purbanchal University School of Health Sciences (PUSHS-IRC Ref. no.: 029-080/81). The hospital administration permission was also taken before collecting the data (Koshi Hospital Ref. no.: 2194).

Consent

Each participant's written and verbal informed consent was taken before collecting their data. Confidentiality and patient rights were maintained. Participants were involved voluntarily and allowed to withdraw from the study at any step if they wished.

Conflicts of Interest

The authors declare no conflicts of interest.

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