



Original Article

## Prescription Analysis of Post Stroke Patients Attending Geriatric Clinic on The Basis of Beers Criteria 2023

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### ABSTRACT

**Background :** The growing elderly population worldwide, especially in countries like India, has increased chronic illnesses and polypharmacy. Post-stroke older adults are particularly susceptible to potentially inappropriate medications and their associated adverse effects.

**Objectives:** The study aims to determine how frequently potentially inappropriate medications (PIMs) are prescribed to post-stroke elderly patients, examine the demographic, clinical, and prescribing factors associated with these PIMs, and evaluate all prescriptions using the 2023 Beers Criteria.

**Materials and Methods:** A questionnaire-based observational study was carried out among 100 post-stroke patients aged 60 years and above. Demographic, clinical, and medication data were collected through interviews, and PIMs were identified using the 2023 Beers Criteria. Associations between PIMs and factors such as age, gender, stroke type, polypharmacy, and multimorbidity were analyzed using the chi-square test.

**Results:** Out of 100 post-stroke patients, the mean age was  $67.58 \pm 6.78$  years, with 75% men and 84% aged 60–75 years. Most (86%) had at least one comorbidity, mainly hypertension (74%). Polypharmacy was common (89%), with an average of 7.37 drugs per patient. Overall, 76% received at least one PIM, most often proton pump inhibitors (53%) and diuretics (22%). Polypharmacy showed a significant association with PIM use ( $p = 0.0004$ ).

**Conclusion:** This study showed a high rate of PIM use (76%) among elderly post-stroke patients, mainly driven by polypharmacy. Proton Pump Inhibitors and diuretics were the most common PIMs. The findings emphasize the importance of routine medication review using updated criteria to improve prescribing safety and reduce adverse effects.

**Keywords:** Aged, Inappropriate prescribing, Polypharmacy, Potentially inappropriate medication list, Stroke.

### INTRODUCTION:

The global rise in the elderly population—from 9% in 1990 to 12% in 2013—is projected to reach 21% by 2050, with India's proportion of adults aged 60 and above expected to increase from 8% in 2010 to 19% by 2050.<sup>[1]</sup> Aging leads to reduced physical and cognitive function and a higher burden of chronic diseases.<sup>[2]</sup> In India, lifestyle-related non-communicable diseases affect nearly one in four people, and stroke remains a major health challenge, ranking as the world's third leading cause of death in 2021, with national incidence rates of 105–152 per 100,000 and wide regional variation.<sup>[3,4,5]</sup>

Older adults commonly experience multiple chronic conditions that often require several medications, increasing the likelihood of polypharmacy and heightening the risk of receiving potentially inappropriate medications (PIMs).<sup>[6,7]</sup> PIMs are defined as drugs where the risk outweighs the benefit when safer alternatives exist, and their use is especially common in older adults with multimorbidity.<sup>[8]</sup> The resulting negative impact on health systems—through avoidable hospitalisations, increased medication burden, and rising morbidity and mortality—makes PIM use a significant global concern.<sup>[9]</sup>

The Beers Criteria, first introduced in 1991 by Dr. Mark Beers, identify medications that may pose risks to older adults due to age-related physiological changes, with the American Geriatrics Society releasing its seventh update in 2023 and fourth under its stewardship since 2011.<sup>[10]</sup>

Although several studies have assessed potentially inappropriate medication (PIM) use in older adults using previous versions of the criteria, research utilizing the 2023 update remains limited, particularly among post-stroke populations. To date, no study has specifically evaluated PIM prescribing in elderly post-stroke patients based on the 2023 Beers Criteria. Therefore, this study aims to determine the prevalence and types of PIMs in this group using the latest Beers framework.

## Materials and Methods:

### Study Design and Population

This cross-sectional, questionnaire-based observational study was conducted in the Geriatric Outpatient Department (OPD) of a tertiary care government hospital over two months (February–March 2025). Ethical approval was obtained (Acad./IEC/2025/616). Patients of either sex, aged 60 years or older, with a history of one or more episodes of stroke (either ischemic or haemorrhagic) occurring more than six months prior, were included after providing written informed consent. Individuals who were recently diagnosed with stroke, terminally ill, or had permanent disabilities were excluded.

### Sample Size

The sample size of 100 was calculated using Cochran's formula, incorporating an additional 5% to compensate for possible non-responses. The calculation assumed a 6% stroke prevalence among Geriatric OPD attendees based on prior studies, with a 95% confidence level and 5% margin of error.<sup>[11]</sup>

### Data Collection

Patients who met the inclusion criteria were recruited through convenience sampling during their visit to the Geriatric OPD. The study was explained in the participants' native language to ensure comprehension, and participation was voluntary with the option to withdraw at any time. Written informed consent was obtained from all eligible individuals. Data were collected through in-person interviews conducted by the trained lead investigator using a predesigned, structured questionnaire-based case record form over a two-month period. The form captured demographic details, medical history, current illness, and all prescribed medications, including drug name, dose, frequency and route. The total number of medications was recorded to identify polypharmacy, commonly defined as the concurrent use of five or more drugs.<sup>[6]</sup> The duration since the initiation of stroke treatment was also documented.

### Study Tools

The questionnaire was developed after an extensive review of relevant literature and validated by faculty from the Departments of Pharmacology and Medicine. Each interview took approximately 8–10 minutes, during which current prescriptions were recorded and screened for PIMs based on the American Geriatric Society (AGS) Beers Criteria 2023. Although the Beers Criteria primarily target adults aged 65 years and above, their purpose is to identify inappropriate prescribing in older adults; therefore, this study included individuals aged 60 years or older, consistent with United Nations (UN) and national guidelines as well as previous research.<sup>[12,13,14]</sup> The 2023 updated AGS Beers Criteria categorize PIMs into five groups.<sup>[10]</sup>

1. PIMs are to be avoided regardless of diagnosis or disease.
2. PIMs to be avoided in specific diseases or syndromes (drug–disease or drug–syndrome Interactions).
3. PIMs that should be used with caution.
4. PIMs involving potentially inappropriate drug–drug interactions.
5. PIMs are to be avoided or used at reduced doses in patients with reduced kidney function.

Prescriptions were assessed for PIMs under the first four categories, while the renal dose-adjustment category was excluded due to the lack of recent laboratory reports in most OPD patients. In cases where two prescribed drugs formed a potentially inappropriate drug–drug interaction, they were counted as a single PIM.

### Statistical Analysis

Data were entered in Microsoft Excel 11.0, and chi-square tests were used to evaluate associations between PIM occurrence and variables such as age (60–75 vs.  $\geq 76$  years), gender, multimorbidity, polypharmacy, and stroke type. A p-value  $< 0.05$  was considered statistically significant. Statistical analysis was done using SPSS version 21.0 (IBM Corp., Armonk, NY), and PIM prevalence was determined according to the 2023 Beers Criteria.

## Results:

### Demographic characteristics of the participants

A total of 100 patients were enrolled, including 75 men and 25 women. The mean age was  $67.58 \pm 6.78$  years (range 60–85). No significant age difference was observed between male and female participants ( $p = 0.115$ ). Most patients (84%) were aged 60–75 years, while 16% were above 75 years as shown in Table 1.

### Comorbid Characteristics of the Participants

Most participants had multimorbidity, with 86% reporting one or more comorbidities besides stroke, and 14% having stroke as the only condition (Table 1). Hypertension was the most prevalent comorbidity (74%), followed by diabetes (24%), coronary artery disease (11%), and thyroid disorders (7%). Overall, 58% had one comorbidity, 33% had two, and 9% had more than two. No significant difference in comorbidity distribution was observed between men and women ( $p=0.9613$ ).

### Polypharmacy Among Participants

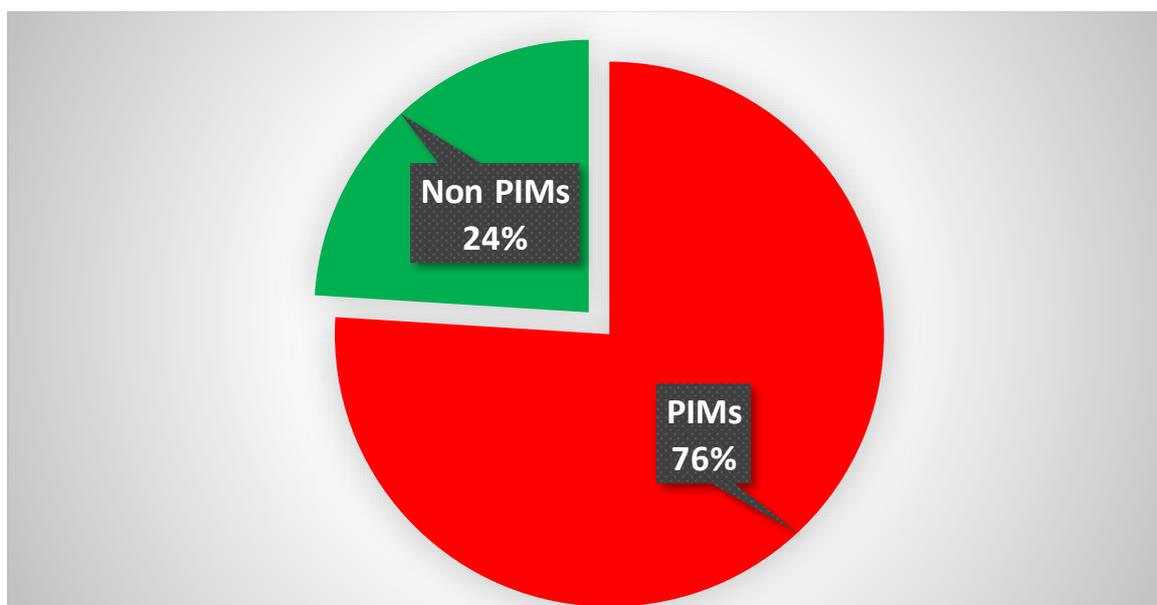
A total of 737 medications were prescribed, with an average of  $7.37 \pm 2.50$  drugs per prescription. The number of drugs did not differ significantly between men and women. However, polypharmacy showed a strong association with PIM use ( $p=0.0004$ ), indicating that the risk of receiving a PIM increased with a higher medication count (Table 1). The number of drugs per prescription ranged from 3 to 15. Commonly prescribed medications included Aspirin (88%), Atorvastatin (74%), Clopidogrel (53%), Pantoprazole (47%), Amlodipine (38%), Losartan (33%), and Telmisartan (26%). Overall, 89% of participants experienced polypharmacy (Table 1), with 12% receiving more than ten medications, and one patient receiving 15 drugs.

**Table 1:** Demographic and Clinical Characteristics of Participants and the Prevalence of Potentially Inappropriate Medications (n=100).

Variables	Number of prescription without PIMs, n (%)	Number of prescriptions with PIMs, n (%)	Total number of prescriptions, n	Level of significance p-value
Age group (years)				
60-75	22 (26.2)	62 (73.8)	84	0.3445
$\geq 76$	2* (12.5)	14 (87.5)	16	
Gender				
Male	19 (25.4)	56 (74.6)	75	0.5886
Female	5 (20)	20 (80)	25	
Number of comorbidities				
$\geq 1$	19 (22.1)	67 (77.9)	86	0.3144
None	5* (35.7)	9 (64.3)	14	
Polypharmacy				
Absent (< 5)	8* (72.7)	3 (27.3)	11	<b>0.0004**</b>
Present ( $\geq 5$ )	16 (17.9)	73 (82.1)	89	
Type of stroke				
Ischemic	21 (24.1)	66 (75.9)	87	1
Haemorrhagic	3* (23.1)	10 (76.9)	13	
*Fisher's exact test applied, as expected value is $\leq 5$ . **Factors found to be significant with p-value < 0.05 PIMs: Potentially inappropriate medications				

### Potentially Inappropriate Medications in the Study Population

Of the 737 medications prescribed, 130 were identified as PIMs, with 76% of patients receiving at least one PIM according to the 2023 AGS Beers Criteria (Figure 1). There was no significant difference in PIM prescribing between males and females, nor any association with age or multimorbidity (Table 1). The number of PIMs per prescription ranged from one to six: 44% had one PIM, 22% had two, 4% had three, another 4% had five, and 1% received six PIMs.



**Figure 1:** Proportion of Prescriptions Containing at Least One Potentially Inappropriate Medication (PIM) (n=100).

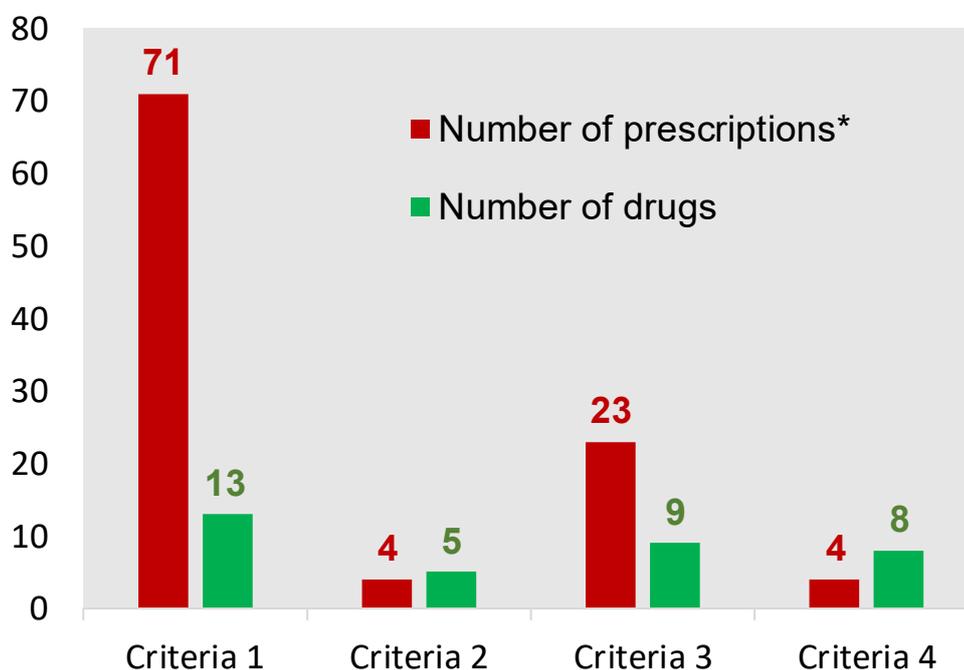
The most common PIM class was proton pump inhibitors (53%), followed by diuretics (22%). Other frequently prescribed PIMs included hypoglycemic agents (13%) and antidepressants (10%). A complete classification of all PIMs across the Beers categories is provided in Table 2. All identified PIMs carried a strong recommendation level under the AGS Beers 2023 guidelines.

**Table 2:** Potentially Inappropriate Medications (PIMs) Identified According to Beers Criteria and Their Frequency among Participants (n=76).

Category of PIMs	Drug class/ Drugs	Number of participants, n*
To be avoided		71
	Proton pump inhibitors	39
	NSAIDs	8
	Anti-diabetics	4
	Antidepressants	1
	Benzodiazepine	1
	Central alpha agonist	1
	PPIs / Anti-diabetics	9
	PPIs / Anti-diabetics / Central alpha agonist	1
	PPIs / NSAIDs / Peripheral $\alpha$ blocker	1
	PPIs / Anticoagulant	1
	PPIs / Benzodiazepines	2
	Anticoagulant / Digoxin	1
	Antidepressant / Benzodiazepine / Central alpha agonist	1
	NSAIDs / Antipsychotic	1
	Drug disease interaction	
	Fluoxetine / Oxcarbazepine (history of fall)	1
	Clonazepam (cognitive impairment)	1
	Aspirin (heart failure)	1
	Diltiazem (heart failure)	1
To be used with caution		23

	Hydrochlorothiazide	13
	Fluoxetine	2
	Amitriptyline	2
	Olanzapine	1
	Torsemide	1
	Fluoxetine/Oxcarbazepine/Hydrochlorothiazide	1
	Dabigatran/ Torsemide/ Spironolactone	1
	Fluoxetine/ Hydrochlorothiazide	1
	Furosemide/ Spironolactone	1
Drug-drug interaction		4
	Telmisartan and Ramipril	2
	Gabapentine and Amitriptyline and Clonazepam	1
	Spironolactone and Ramipril/ Furosemide and Carvedilol	1
*The sum of 'n' values exceeds the total number of participants with PIMs, as some participants had PIMs from multiple categories.		
PPIs: Proton pump inhibitors, NSAIDs: Nonsteroidal anti-inflammatory drugs		

Comparison of the total number of PIM prescriptions with the distribution of medications across each Beers category, assessing individual drug–drug interaction medications separately is shown in figure 2.



**Figure 2:** Comparison of Potentially Inappropriate Medication (PIM) Prescriptions and the Number of Drugs within Each Beers Criteria Category (n=76).

\*The sum of 'n' values exceeds the total number of participants with PIMs, as some participants had PIMs from multiple categories.

#### Discussion:

The identification and assessment of potentially inappropriate medications (PIMs) in elderly post-stroke patients represents a crucial yet underexplored area. Older stroke survivors frequently present with complex medical needs arising from multimorbidity, polypharmacy, and functional impairments.<sup>[15]</sup> Despite this, there is limited data specifically examining the prevalence and clinical consequences of PIMs in this population. Therefore, evaluating PIMs in elderly post-stroke patients is essential not only to optimize pharmacological management but also to reduce preventable harm and improve treatment outcomes.

In our study, males predominated (75%), with a mean age of  $67.58 \pm 6.78$  years, reflecting established epidemiological trends of higher stroke incidence among older men.<sup>[16]</sup> Although the age difference between genders was not statistically significant, the participants appeared comparatively younger than in similar studies, likely due to India's lower life expectancy and the intentional exclusion of terminally ill individuals or those with permanent disabilities.<sup>[17]</sup> Nevertheless, the mean age of participants is comparable to findings from other studies conducted in various regions of India.<sup>[18-21]</sup>

The high prevalence of multimorbidity (86%) highlights the complex clinical landscape frequently encountered in stroke survivors. Hypertension was the most common comorbidity (74%), followed by diabetes (24%) and coronary artery disease (11%), consistent with well-established associations between these conditions and cerebrovascular events.<sup>[22]</sup> The absence of a statistically significant difference in comorbidity distribution between genders indicates that the burden of co-existing conditions is similar in both male and female stroke patients in this cohort.

Polypharmacy was also highly prevalent (89%), with an average of  $7.37 \pm 2.50$  medications per prescription and a range of up to 15 drugs. Similar findings were reported in another study, where the maximum number of drugs per prescription was 17.<sup>[23]</sup> This degree of polypharmacy raises concerns about adverse drug events, drug-drug interactions, reduced medication adherence, and poorer clinical outcomes, particularly in the elderly due to age-related physiological changes and potential frailty.<sup>[24]</sup> Moreover, polypharmacy was significantly associated with the use of potentially inappropriate medications (PIMs) ( $p = 0.0004$ ). The most frequently prescribed drugs – Aspirin (88%), Atorvastatin (74%), Clopidogrel (53%), Pantoprazole (47%), Amlodipine (38%), Losartan (33%), and Telmisartan (26%) – reflect standard care for secondary stroke prevention and management of cardiovascular risk factors.<sup>[25]</sup> Nonetheless, the high number of medications necessitates careful evaluation for appropriateness and potential interactions.

The prevalence of potentially inappropriate medications (PIMs) was notably high, with 76% of participants receiving at least one according to the 2023 AGS Beers criteria.<sup>[14,26]</sup> Matsumoto et al. reported 65.4% PIMs in a stroke study ( $n = 234$ ), highlighting the vulnerability of this population.<sup>[27]</sup> In our study, 17.6% ( $n = 130$ ) of all prescribed drugs were PIMs, similar to Anand et al.<sup>[14]</sup>

Most PIMs (71%) fell under Criterion 1 of the Beers criteria. Proton pump inhibitors (53%) were the most common, reflecting gastroprotection in antiplatelet users, but long-term use may cause *Clostridium difficile* infection, fractures, and vitamin B12 deficiency.<sup>[14,28]</sup> Anti-diabetic drugs such as Glimepiride and short-acting insulin (13%) pose hypoglycemia risk, suggesting safer alternatives. Non-steroidal Antiinflammatory drugs (NSAIDs) (11%), including diclofenac and naproxen, increase gastrointestinal bleeding risk, especially when combined with antiplatelet or anticoagulant therapy.

Beers Criteria Category 2 identifies medications potentially inappropriate for patients with certain diseases, as they may worsen the condition or increase adverse outcomes. In our study, 4% of participants had such drug-disease interactions. For example, aspirin and diltiazem in heart failure patients may exacerbate fluid retention, clonazepam can impair cognition and increase confusion, and the combination of fluoxetine and oxcarbazepine may heighten fall risk.

Criterion 3, the “to be used with caution” category, accounted for 23% of PIM prescriptions, with diuretics (hydrochlorothiazide, torsemide, furosemide) being the most frequent (18%), consistent with Zhang et al.<sup>[29]</sup> Diuretics pose risks in the elderly, including electrolyte imbalance, dehydration, and falls. Antidepressants such as fluoxetine and amitriptyline (6%) were also notable, reflecting the need for careful use due to risks like hyponatremia, sedation, and fall susceptibility.

Drug-drug interactions were notable, particularly the concomitant use of two renin-angiotensin system (RAS) inhibitors (3%), which increases hyperkalemia risk in chronic kidney disease patients, consistent with another Indian study.<sup>[1]</sup> Similarly, prescribing three or more CNS-acting drugs in a single patient raises concerns for additive sedation, cognitive impairment, and falls.<sup>[30]</sup>

All identified PIMs carried a strong recommendation according to the 2023 AGS Beers Criteria, underscoring their clinical significance. These findings highlight the high prevalence of polypharmacy and PIMs in elderly stroke patients, emphasizing the need for interventions to optimize medication management. Strategies include regular medication review, clinician education on Beers Criteria and PIM risks, use of decision-support tools like STRIP and real-time EHR alerts, and a collaborative interprofessional approach involving physicians, pharmacists, nurses, and clinical pharmacologists.<sup>[31-33]</sup> Such measures aim to enhance prescribing practices, minimize PIM use, and improve medication safety and outcomes in older adults.

### **Limitations:**

The single-centre design and modest sample size may limit the generalizability of our findings. Additionally, the cross-sectional design captures medication use at a single time point and does not reflect changes in prescribing over the disease

course. Future longitudinal, multi-centre studies are needed to validate these results and assess the impact of PIMs on clinical outcomes in stroke survivors.

#### **Strength:**

To our knowledge, this is the first Indian study using the 2023 Beers Criteria to identify PIMs in elderly post-stroke patients. Medication data were collected directly from patients, minimizing errors from recall or incomplete records and reducing bias from duplicate counting of the same drug under different names or formulations.

#### **Conclusion:**

Prescription of potentially inappropriate medicines is alarmingly high among post-stroke elderly patients. Multimorbidity and polypharmacy are found to be high among elderly patients, possibly increasing the risk of PIM prescriptions. These findings demonstrate the clinical utility of the 2023 AGS Beers Criteria in identifying inappropriate prescribing. There is an urgent need to increase awareness among prescribers regarding PIMs and associated risks to promote safe and effective medication management. Routine medication review and rational prescribing strategies are essential to enhance medication safety in this vulnerable group.

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