ENHANCING SAFER PRESCRIPTIONS FOR SENIORS: A CROSS-SECTIONAL STUDY ON THE EVALUATION OF PRESCRIPTION PATTERN AND CHANCES OF PRESCRIBING POTENTIALLY INAPPROPRIATE MEDICATIONS IN GERIATRIC PATIENTS USING "AGS BEERS CRITERIA 2019"

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ABSTRACT

Objective: This study aimed to assess the prescribing pattern and frequency of potentially inappropriate medications (PIMs) in geriatrics based on the AGS Beers Criteria 2019.

Methods: With an aim to Contributing to *elderly healthcare improvement*, a *six-month prospective cross-sectional study* was conducted in a tertiary healthcare center from *May to October 2022*. The sample included 108 hospitalized patients, regardless of gender, each prescribed at least one medicine. Using the *AGS Beers Criteria* as a reference, the study team extracted information from patient records for prescription analysis, and the collected data were analyzed using Statistical Package for Social Sciences (*SPSS)*.

Results: Among the 108 participants, *61.11% were men, and 38.89% were women*, with the majority (45.37%) in the 65-69 age group. Of the 815 medications examined, *10.67% were potentially inappropriate*. There were 56.32%, 0%, 33.33%, 1.15%, and 9.2% PIMs in Category I, II, III, IV, and V of Beer's criteria respectively. *Insulin, Glimepiride, and Furosemide* was themost frequently prescribed PIMs..

Logistic regression revealed a significant association between the *likelihood of prescribing PIMs with the number of comorbidities* (OR: 0.042, 95% CI: 1.018 to 2.827, p=0.42) *and the number of drugs* (OR: 1.204, 95% CI: 1.015 to 1.429, p=0.33).

Conclusion: This study emphasizes the *need for vigilance in prescription practices* for geriatric patients. Identifying commonly prescribed PIMs and re-evaluating them, considering co-morbidities and the number of

drugs prescribed, are crucial steps to enhance appropriateness and quality of care for geriatric patients.

Keywords: AGS Beer's criteria, older adults, potentially inappropriate medication (PIM), safer prescription, Good prescription practice, Geriatric care.

INTRODUCTION

Geriatrics, the branch of medicine focused on elderly patients, is a challenge to define precisely, but it's commonly associated with those aged 65 and older, there has been a ***notable decade-by-decade growth in the elderly population***, with a shift from 35.5% in the period of 2001-2011 to 35.8% in 2011-2021, and it is projected to reach 40.5% by 2021-2031[1]. Geriatric patients often grapple with multiple concurrent medical conditions, leading to frequent hospital admissions, a scenario that significantly heightens the risk of polypharmacy and other drug-related complications, necessitating careful management. Doctors face a unique challenge when treating older patients, because of the alteration ***in Pharmacokinetic-Pharmacodynamic parameters***, which makes it necessary to address the geriatric patients through a holistic, multidisciplinary approach [2].

Potentially inappropriate medications (PIMs) are medications where the potential for adverse events outweighs their clinical benefits, especially when safer or more effective alternatives are available. This issue is especially concerning for the elderly, who are more susceptible to negative drug effects because of 1) The challenges arise due to ***limited research*** on medication use in this age group and their ***exclusion from clinical trials***, 2) Many elderly individuals take ***multiple medications*** for various health conditions, leading to drug interactions, and adverse drug reactions, 3) ***Altered physiology*** and Age-related ***forgetfulness*** may be significant factors for poor compliance. 4) Inadequate ***monitoring and communication gaps*** can further compound these problems [3-6]. With the elderly population receiving a high number of prescriptions, healthcare professionals must strike a delicate balance between prescribing safe and medically necessary medications to improve health outcomes while minimizing adverse drug events and ensuring better health outcomes as well [7].

Approximately two decades ago, ***Dr. Mark H. Beers and colleagues*** emphasized the importance of averting harmful medication events in the elderly. It's one of the ***globally recognized*** and widely adopted, with a strong focus on ***de-prescribing unnecessary medications*** [8]. The AGS Beers Criteria includes lists of specific medications that should be discussed with medical specialists because they may not be the safest or most appropriate choices for older individuals. They play a significant role in raising awareness about inappropriate medication use in geriatric patients, prompting healthcare professionals to pause, assess the risks of specific treatments, and thoroughly explore both pharmaceutical and non-pharmaceutical alternatives [9].

The Beers Criteria serves as a reference for physicians, complementing their expertise rather than as a replacement for their clinical judgment while deciding the most suitable medications for individual patients. The Beers Criteria aids medical personnel in clearly identifying and classifying medications used in geriatrics [10]. Healthcare practitioners can streamline medication prescription, prioritize drug selection, choose the most suitable medications, and reduce medication-related costs using this classification system, ultimately minimizing drug-related issues [11].

Most of the other studies have primarily assessed the prevalence of PIMs by calculating the ratio of PIM prescriptions to the total number of prescriptions. Our study, however, tried to present our findings as the total number of PIMs relative to the total number of prescribed drugs. This unique approach presents a new angle on the matter and may throw new insight into how common PIMsare in clinical practices.

METHODOLOGY

Study type: A *prospective cross-sectional* study to evaluate the prescribing pattern, and chances of prescribing Potentially Inappropriate Medications (PIMs) geriatric patients using AGS Beer's criteria 2019.

Study location

The clinical study was conducted on the inpatients and outpatients admitted to the General Medicine department of *The Oxford Medical College Hospital and Research Centre, Attibele, Bangalore.*

Duration of clinical study

This study was conducted for a minimum *6 months* of duration from MAY 2022 to OCTOBER 2022.

Study sources

• Patient case records

• AGS Beers Criteria updated version 2019

• Prescription analysis to identify PIM

Sampling calculation and Sampling method

Based on the prevalence rate of PIMs in the geriatric population in India [12], the sample size was calculated based on the standard formula for a cross-sectional design. Calculated sample sizes of *108 patients* were included in the study through a simple random sampling technique.

Inclusion criteria:

• Patients with informed consent of either sex above 65 years of age admitted to theGeneral Medicine department.

• Both inpatient and outpatient

• Patients with single/ multiple comorbidities, and prescribed at least one daily medication,were included in the study

Exclusion criteria:

- Bedridden and Those who are not willing to participate in the study

- Patients undergoing palliative care or Hospice were excluded.

Ethical approval

This study was approved by the Institutional Ethics Committee of The Oxford Medical College Hospital and Research Centre, Attibele, Bengaluru (IEC reference no.: IEC/TOMCHRC/203/2022-2023).

AGS BEER'S CRITERIA:

The American Geriatrics Society (AGS), established in 1942, is a non-profit organization comprising over 6,000 members, including geriatricians, nurse practitioners, social workers, family practitioners, physician assistants, pharmacists and other healthcare specialists. AGS is dedicated to improving the health, independence, and quality of life of older individuals, emphasizing interprofessional care, personalized treatment, and holistic care [13]. The AGS Beers Criteria undergoes regular updates, contributing to the ongoing enhancement of healthcare education, research, outcomes assessment, and documentation [14]. It also highlights specific medications that carry substantial risks for individuals over the age of 65, which can surpass any potential benefits, thereby promoting the secure and efficient utilization of medications in this demographic [15].

The AGS Beers Criteria 2019 categorize medications into five lists [16]:

1) those to be avoided by most older individuals (except in palliative care),

2) those to be avoided with specific health conditions,

3) those to be avoided with other treatments due to the risk for harmful "drug-drug" interactions,

4) those to be used cautiously due to the risk for potentially harmful side effects., and

5) those requiring adjusted dosages for individuals with impaired renal function.

METHOD OF DATA COLLECTION:

The patient's demographic information, including age, and sex, diagnostic data, and prescribed drugs were gathered. This involved compiling patient case records, medication prescriptions, medical and medication history, laboratory test results, and personal interviews with patients or their attendants to inquire about the patient's over-the-counter (OTC) medication use. The assessment of prescription patterns for Potentially Inappropriate Medications was done using AGS Beer's criteria 2019. The creatinine clearance was calculated using the standard formula of the ***Cockcroft-Gault equation*** i.e., $(140 - \text{age}) \times$ body weight/plasma creatinine $\times$ 72 (multiplied by 0.85 if female).

The collected data was subjected to data analysis in ***SPSS software*** version 20 and the association between PIM prescription and categorical variable (such as gender) was analyzed using an independent student t-test, and the association between PIM prescription and numerical variable (such as age) was analyzed with respect to odds ratio using logistic regression at the ***95% confidence interval***. The ***p-value < 0.05*** indicates statistical significance.

RESULTS

In this research, we examined ***108 patients*** who met specific inclusion criteria and assessed their medication prescriptions. Among these patients, ***66 (61.11%) were male, and 42 (38.81%) were female***. The ***average age*** of the study participants was approximately ***71.99 years***, with a standard deviation of ± 7.265. Among the 108 patients, ***49 (45.38%) fell into the 65 to 69 years***

age bracket, 23 (21.29%) were in the 70 to 74 years age bracket, 12 (11.11%) in each of the 75 to 79 years, 80 to 84 years, and 85 to 90 years age group.

The *average number of comorbidities* in the study sample was found to be *2.02, (S.D ±1.085)* and the most commonly diagnosed condition was Type II diabetes mellitus in 41 (37.96%) patients, followed by Hypertension in 39 (36.11%) patients, and Chronic Obstructive Pulmonary Disease in 15 (13.88%) patients, etc., In this study, a *total of 815 medications* were prescribed, and *87 of them were potentially inappropriate medications (PIMs)*, accounting for about 10.67% of the total prescribed medications. The demographic details of the elderly patients and the significance of these findings are presented in *Table 5.1.*

Among the 815 medications, 462 medications were prescribed to male patients, of which 417 (90.26%) were classified as non-PIMs, while 45 (9.74%) were identified as PIMs. Similarly, out of the 353 medications prescribed to female patients, 311 (88.10%) were non-PIMs, and 42 (11.90%) were PIMs (*Figure 1*). In our research, the patients we studied encompassed a broad age range, ranging from 65 to 90 years. When it comes to potentially inappropriate medications (PIMs), their occurrence varied across distinct age categories. Specifically, within the 65 to 69 years group, we encountered 35 instances of PIMs (9.94%) which means 317 (90.06%) non-PIMs were there in this age bracket. Likewise, for individuals aged 70 to 74 years, we noted 20 PIMs (11.11%) of the prescribed treatments. In the 75 to 79 years age bracket, we identified 12 (12.50%) occurrences of PIMs of the total medications. Similarly, in the 80 to 84 years age group, there were 12 (13.79%) incidents of PIMs of the prescribed drugs. Lastly, in the 85 to 90 years age category, 8 (8%) instances of PIMs of the prescribed medications.
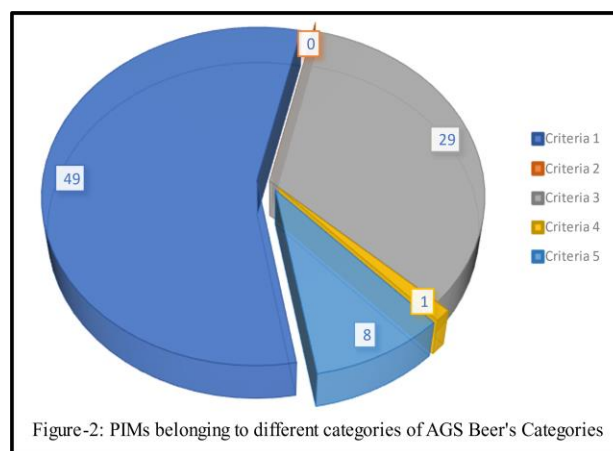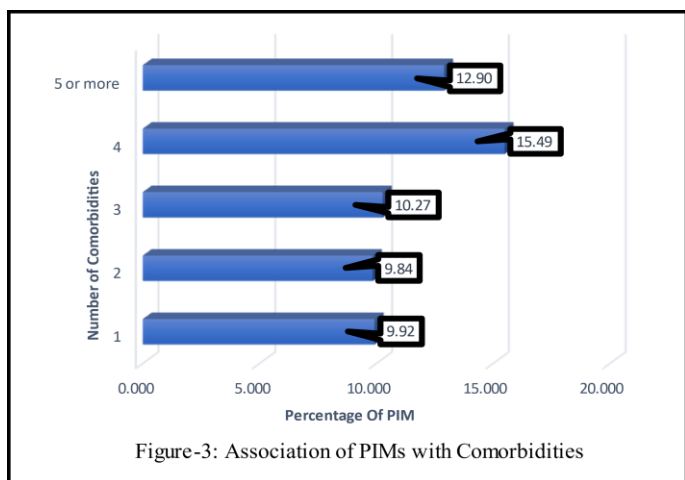

Figure-1: Comparison of PIMs and Non-PIMs
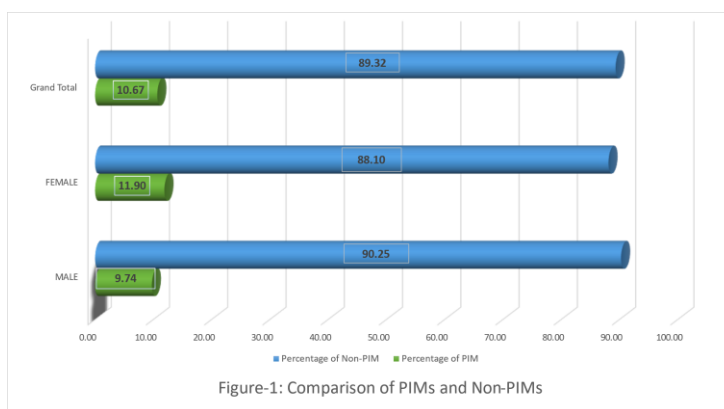
This analysis showed that *patients with four comorbidities had the highest number of PIMs, with 15.49% of their prescribed drugs identified as PIMs*. Conversely, patients with two comorbidities had the fewest PIMs, with 9.84% of their medications categorized as PIMs based on AGS Beer's criteria 2019. The *most frequently prescribed PIMs* in this study were found to be *Insulin, occurring 18 times (20.68%).* This was followed by Furosemide and Glimepiride, both prescribed 17 times (19.54%) each. We also provided alternative medications to consider for the identified PIMs.

Our study revealed that the *highest number of PIMs (44) were associated with Type II diabetes mellitus, followed by hypertension, lower respiratory tract infections*, etc., When it comes to Beer's criteria classifications, out of the 87 PIMs,
49 (56.32%) fell into Category I. There were no PIMs in Category II. Category III included 29 (33.33%) PIMs. Only 1 (1.15%) PIM was present in Category IV, and Category V had 8 (9.20%) PIMs in our study.

In our study, we analyzed the medication regimens of patients and found that each patient was taking an *average of 7.55 medications (SD± 3.242).* With respect to polypharmacy, we observed that out of the *31 patients who were prescribed 1 to 5 drugs*, *17 instances (12.78%)* involved Potentially Inappropriate Medications (PIMs). For the *65 patients receiving 6 to 11 drugs*, there were *47 cases of PIMs (9.27%).* Additionally, *12 patients* who were prescribed *more than 11 drugs had 23 instances of PIMs (13.15%) (Figure 3).*

Our study aimed to identify the *factors influencing* the likelihood of prescribing PIMs. To examine the relationship between gender and PIM prescriptions, we employed an independent t-test. Interestingly, our analysis indicated that Gender ($p=0.63$, 95% CI: -0.655 to 0.018) was not
significantly linked to the likelihood of PIM prescription. We also employed a logistic regression and found that Age (OR: 1.022, 95% CI: 0.96 to 1.087,
$p=0.498$) was not significantly associated with the likelihood of PIM prescription. However, we discovered that the *presence of comorbidities* (p-value: 0.042, 95% CI: 1.018 to 2.827) was
indeed significantly associated with PIM prescriptions, with an odds ratio of 1.697.

Figure-3: Association of PIMs with Comorbidities

Figure-2: PIMs belonging to different categories of AGS Beer's Categories

Another influential factor significantly affecting PIM prescriptions was the ***number of drugsprescribed*** (p-value: 0.033, 95% CI: 1.015 to 1.429), with an odds ratio of 1.204.

Variable	Number of Patients (%) (N=108)	Mean (SD)	Total Drugs Prescribed (n=815)	Total PIM out of total drugs prescribed (%)	p-value
Gender					
o Male	66 (61.11)		462 (56.69)	45 (9.74)	0.306
o Female	42 (38.89)		353 (43.31)	42 (11.90)	
Age (years)					
o 65-69	49 (45.37)		352 (43.19)	35 (9.94)	
o 70-74	23 (21.30)	71.99 (7.265)	180 (22.09)	20 (11.11)	
o 75-79	12 (11.11)		96 (11.78)	12 (12.5)	0.498
o 80-85	12 (11.11)		87 (10.67)	12 (13.79)	
o 86-90	12 (11.11)		100 (12.27)	8 (8)	
Presence of comorbidities:					
o 1-4	103 (95.37)	2.02 (1.085)	753 (92.39)	79 (10.49)	*0.042**
o >/=5	5 (4.63)		62 (7.61)	8 (12.9)	
Number of drugs given:					
o 1-5	31 (28.70)		133 (16.32)	17 (12.78)	
o 6-10	65 (60.19)	7.55 (3.242)	507 (62.21)	47 (9.27)	*0.033**
o >/=11	12 (11.11)		175 (21.47)	23 (13.14)	

*Indicates statistically significant association

Table 1: demographic details of the study sample

Alternatives for most identified PIMs is given below

1. ***Human Insulin*** (Quality of Evidence = Moderate; Strength of recommendation = Strong)
   - It's recommended to avoid using insulin regimens that solely rely on short- or

rapid-acting insulin, adjusted based on your current blood sugar levels, without adding a ***steady basal or long-acting insulin*** like Insulin glargine or Insulin detemir. Consider ***combining Exenatide and Pioglitazone*** for better control [17].

2. ***Glimepiride*** (Quality of Evidence = High; Strength of recommendation = Strong) - medications like ***glipizide and gliclazide*** can be considered with careful dosing. Alternatively, you can explore other medications such as ***Alpha-glucosidase inhibitors, Dipeptidyl peptidase-4 (DPP-4) inhibitors, Metformin, and Thiazolidinediones***. These alternatives carry little to no risk of causing hypoglycemia [18].

3. ***Furosemide*** (Quality of Evidence = Moderate; Strength of recommendation = Strong) - Effective alternative options include ***ACE inhibitors (ACEI), Angiotensin II receptor blockers (ARB), and long-acting calcium channel blockers (CCB)*** [19].

DISCUSSION:

This study delves into the prescribing patterns in geriatric care and the likelihood of prescribing potentially inappropriate medications (PIMs) based on the 2019 AGS Beer's criteria. In our study, we analyzed 108 prescriptions, which included a total of 815 medications. Of these, 87 medications (10.67%) were identified as PIMs, while 728 medications (89.33%) were considered safe (non-PIMs) for older adults. Most previous research on this subject has expressed their findings as the prevalence of PIMs by calculating the ratio of PIMs to the total number of prescriptions. However, our study takes a different approach by expressing the results as the percentage of PIMs in comparison to the total number of drugs given to the study participants, allowing us to gauge the overall probability of prescribing PIMs rather than at an individual prescription level. This unique approach prevents us from direct comparison of our results with other studies that have traditionally calculated PIM prevalence based on the total number of prescriptions.

Out of the 87 identified PIMs, the majority, 49 of them (56.32%), belonged to Category 1, which includes drugs considered potentially inappropriate for older adults. This is consistent with the results of the study by B Chitra et al [20], where 95% of PIMs were in Category 1. We didn't find any PIMs related to drug-disease or drug-syndrome interactions (Category 2 PIMs) in our study, notably this result is in line with the findings of Pooja Anand et al [21], who also reported 0 PIMs in Category 2.

The most frequently prescribed PIM in our study was Insulin (sliding scale) at 20.69%, followed by Glimepiride and Diuretic Furosemide, both at 19.54%. This higher percentage of Insulin as a PIM in our study might be attributed to the higher prevalence of diabetic patients in our sample compared to the prevalence of diabetes in geriatric populations reported by Alan Sinclair et al [22]. Similarly in a recent study by Rishabh Sharma et al [23], they found that the most potentially inappropriate medications (PIMs) prescribed were Insulin and glimepiride. However, a study by

Nader Motallebzadeh et al [24] presented different results. In their study, Digoxin (25%) and Spironolactone (19.64%) were the most commonly prescribed PIMs.

Insulin carries a higher risk of causing low blood sugar (hypoglycemia), regardless of the care setting. This risk doesn't apply to regimens that include basal insulin or long-acting insulin. On the other hand, long-acting sulfonylurea, Glimepiride, poses a significant risk of prolonged hypoglycemia. Elderly individuals, due to age-related changes in hormone responses, are more susceptible to hypoglycemia, as shown in a study by Supriya Mathur et al [25].

Pegg et al [26] reported that older adults are less aware of the symptoms of hypoglycemia. Therefore, these PIMs should be used with caution. If prescribed, patients should receive counseling about the risk of hypoglycemia, its symptoms, precautions, and potential interactions with alcohol or other medications. Moving on to another medication, Furosemide, a diuretic, has the potential to exacerbate or cause a syndrome of inappropriate antidiuretic hormone secretion (SIADH) or Hyponatremia. It's advisable to monitor sodium levels when starting or adjusting the dose of this diuretic.

Our current study aimed to identify factors related to the prescription of PIMs. Interestingly, gender (p=0.63, 95% CI: -0.655 to 0.018) did not show a significant association with PIM prescription. This differs from the findings of Rishabh Sharma and colleagues [27], who reported that male gender was a significant predictor for PIMs prescription (p=0.02, 95% CI: -0.03 – 0.93). The factor of Age (OR: 1.022, 95% CI: 0.96 to 1.087, p=0.498) did not appear to be significantly associated with PIM prescription, which is akin to the study conducted by Asma Ahmed Abdelwahed and her team [28].

Our study revealed that the presence of comorbidities (p-value: 0.042, 95% CI: 1.018 to 2.827) was significantly associated with PIM prescription, with an odds ratio of 1.697. This aligns with the findings of Fangyuan Tian [29] and San-Jose [30]. Another crucial factor linked to PIM prescription was the number of drugs (p-value: 0.033, 95% CI: 1.015 to 1.429), with an odds ratio of 1.204. The studies conducted by San Jose et al [30] and Hannah K. Doody et al [47] support this study's findings.

The AGS Beer's criteria help healthcare providers make better drug choices for older adults, reducing the risk of adverse drug reactions, drug interactions, and other medication-related issues. Some studies even suggest that replacing potentially inappropriate medications can lead to pharmacoeconomic benefit for patients. Thus, there is a growing need for evaluating and implementing measures to reduce the use of PIMs.

LIMITATIONS-

1. Our study's findings may have limited applicability to the broader population due to the *small sample size* of 108 participants from a single institution. Additionally, the AGS Beer's criteria *do not cover plant-based therapies, or herbal supplements*, potentially impacting the generalizability of our results.

2. It's essential to note that not all ' Potentially inappropriate' medications necessarily lead to adverse outcomes. There are instances where such medications *may be necessary for certain patients.*

3. Because the trial *only lasted six months*, we were *unable to track down participants* and analyze PIM-related pharmacological adverse reactions, readmission, and mortality.

CONCLUSION:

Our study delves into the frequency of potentially inappropriate medications (PIMs) prescribed, aiming to shed light on better medication choices to elderly patients. We've utilized the AGS Beers Criteria 2019 to evaluate these prescriptions.

Our findings revealed that only 10.67% were potentially inappropriate per AGS Beer's criteria 2019. Notably, the most frequently prescribed PIMs included Insulin, Furosemide, and Glimepiride. It's important to reconsider their use in geriatric prescriptions, but *only, when necessary*, to enhance appropriateness and reduce the risk of PIMs.

Gender and age did not significantly affect the occurrence of PIMs. Instead, comorbidities and the number of medications prescribed played a pivotal role in determining the likelihood of PIMs. This emphasizes the need for *special attention* when prescribing medications to elderly individuals with *multiple health issues* or who are taking *multiple medications* (polypharmacy).

In this era of *digitalization and electronic medical records*, applying the AGS Beers Criteria during geriatric treatment becomes both feasible and valuable. This can substantially enhance the quality of life for the elderly and reduce healthcare costs effectively.

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