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Original Article

Evaluation of Prescriptions among Geriatric Patients Using Beer's Criteria in a Tertiary Care Setting

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ABSTRACT

Introduction: The geriatric population is prone to physiologic changes, thus increasing the risk of medication-related problems. The use of potentially inappropriate medications is associated with profound medical and safety consequences in the elderly and imposes negative economic effects. **Objectives:** To assess drug therapy in geriatric patients using Beer's Criteria and analyze physician's feedback in response to the suggestions provided. **Materials and Methods:** An observational, prospective study was conducted for 6 months using case records of 159 inpatients. A suitably designed data collection form was used to collect data and were analyzed using Statistical Package for Social Science software version 23. **Results:** The majority of subjects prescribed potentially inappropriate medications 59 (47.2%) were aged between 65-74 years among which males 46 (52.8%) were prominent. Of 1920 prescribed medications, 111 (5.78%) have been identified as potentially inappropriate medications (Category 1, 2, 4, and 5), and 125 (6.51%) were the drugs to be used with caution (Category 3). Most commonly prescribed inappropriate medication was glimepiride 18 (16.2%) followed by alprazolam 10(9%) and lorazepam 7(6.3%). **Conclusion:** This study concludes that the prevalence of potentially inappropriate medications among geriatric patients is 43.39%. It is necessary to consider factors such as creatinine clearance when prescribing medicines for geriatrics. Furthermore, awareness among physicians about the Beer's Criteria is required so that they deliver justifiable health care. In light of these findings, regulatory authorities should take action to mandate the implementation of Beer's Criteria.

Keywords: Beer's Criteria, Geriatrics, Prevalence of Potentially inappropriate medications, Polypharmacy.

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INTRODUCTION

The number of aged people has increased globally at an unprecedented rate; this is known as a rapidly ageing world.[1] According to the World Health Organization, one elderly person older than 60 years exists for every nine people.[2] This population growth poses major challenges to the healthcare system such as increasing demand for health resources including medications.[3] Age-related physiologic changes that occur in elderly individuals may affect drug pharmacokinetics and pharmacodynamics, thus increasing the risk of medication-related problems.[4,5]

The use of five or more medications concurrently known as polypharmacy, is quite prevalent in elderly people. In general, polypharmacy is linked to higher drug consumption that may be harmful.[6] It is estimated that some of the medications are potentially inappropriate which may be harmful or unsuitable, causing adverse events.[1] Inappropriate Medications (IM) are defined as medicines that cause more risk than benefit, particularly when safer alternative drugs are available.[7]

The American Geriatric Society (AGS) Beer's Criteria are an explicit list of potentially inappropriate medications that are typically best avoided by older adults in most circumstances or under specific situations such as in certain diseases or conditions. Each of the five types of criteria in the 2015 update were retained in the 2019 update.[8] The primary focus is on how frequently prescriptions are appropriate in light of Beer's Criterion. Given that the population is especially susceptible to polypharmacy and adverse drug reactions, it is crucial to assess prescriptions in geriatrics. As a result, we need a special therapy strategy for overall optimal results. Additionally, assessing adherence to Beer's Criteria is crucial for improving the caliber of medical outcomes. Hence, an analysis of physician's feedback in response to the suggestions provided is also carried out.

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MATERIALS AND METHODS

An observational, prospective study was carried out in an inpatient setting of a tertiary hospital in Mangalore, India, after obtaining approval from the Institutional Ethics Committee (Ref No: FMIEC/CCM/228/2022). Informed consent was obtained from each participant. The study was conducted for 6 months from April to October 2022.

The data sources required for the study were collected from the patient's medical records (case sheets, laboratory investigations, medication charts). Information about the patient was gathered using a self-created form. At the time of admission, the forms were filled out and recorded accordingly.

Using AGS 2019 Updated Beer's Criteria for Potentially Inappropriate Medication Use in Older Adults, each prescription was examined individually for appropriateness. The following details were gathered for each drug order: name, dose, dosage, and frequency of administration. Prescriptions for lotions, ointments, nebulizers, and drops were excluded. Prescription was deemed to be inappropriate if it contains one or more drugs that are listed in Beer's Criteria.

Study Design

A total of 159 participants were enrolled and were selected based on eligibility criteria. The criteria for inclusion involve patients of either sex, belonging to age ≥65 years, admitted in the wards of all the departments. Patients who are in hospice care or receiving palliative care, and discharged before completing their data collection were excluded.

Statistical analysis

Data were collected and entered in Microsoft Office Excel 2019 and analyzed using Statistical Package for Social Sciences (SPSS) software version 23. Descriptive statistical tools, including frequency, percentage, mean, and standard deviation, were used to assess the patient's data. Tests such as the Pearson chi-square test and likelihood ratio were employed. Prevalence was used to assess the number of inappropriate medications. A *p*-value of <0.05 was considered statistically significant.

RESULTS

In this study, the majority of the subjects were male and aged between the group 65-74 years. The length of hospitalization revealed that the patient stayed for ≤5 days. It was observed that, on average, each patient had four diagnoses with a range of 1-11, thus resulting in polypharmacy.

Participants were included from various departments, with general medicine ranking highest, followed by surgery.

The enrolled study subjects were identified with various kinds of disease conditions, with hypertension being the most common comorbidity identified during the study, followed by type 2 diabetes mellitus.

The data was analyzed for the appropriateness of drug therapy. Of the 159 prescriptions evaluated, 69 (43.39%) subjects received inappropriate prescriptions. A total of 1920 drugs were prescribed except for ointments, creams, ophthalmic drops drops, nebulizers, from which 111(5.78%) drugs have been identified as potentially inappropriate medications (Category 1, 2, 4, and 5), and 125 (6.51%) were the drugs to be used with caution (Category 3).

Table 1 focuses on the prevalence of inappropriate medicines using Beer's Criteria. In Category 1, the most prevalent inappropriate drug was found to be glimepiride belonging to the class sulfonylureas, followed by alprazolam then lorazepam belonging to the class benzodiazepine. Aspirin for chronic kidney disease and amitriptyline for fracture were the most commonly prescribed PIMs in Category 2. Tramadol (an opioid analgesic) was the most frequently prescribed drug from Category 3 which is to be used with caution, making up to 32.8% of this class. Majority of the detected interactions from Category 4 resulted from the simultaneous prescribing of opioid (tramadol) and benzodiazepine (alprazolam) followed by tramadol and pregabalin. In Category 5, ranitidine was found to be the most commonly prescribed drug in patients with CrCl<50 mL/min.

Table 2 lists numerous variables that may affect the occurrence of PIMs such as age, gender, length of stay, polypharmacy, and number of diagnoses. The impact of predictors that may enhance the chance of acquiring PIMs was assessed. Among all the 5 variables, gender was found to be statistically significant.

Table 3 depicts the correlation between polypharmacy and variables. The prevalence of polypharmacy was proportional to the number of diagnoses, whereas age and length of hospitalization were found to be inversely proportional. Males were more susceptible to polypharmacy compared to females.

The result obtained was reported to 15 physicians and their feedback was recorded in Table 4.

DISCUSSION

The 2019 AGS Beers Criteria is an important and improved update of previously established criteria in 2015, widely used by healthcare providers, and policymakers as a quality measure. The new criteria are based upon methods for determining best-practice guidelines that included a rigorous systematic literature review, the use of an expert consensus panel, and grading of the strength of evidence and recommendations.

In this study, 69(43.4%) had at least one PIMs and 29(18.24%) had more than two PIMs according to 2019 AGS Beer's Criteria.

The most commonly prescribed drug that was considered as PIM was glimepiride 18(16.2%) followed by alprazolam 10(9%) and lorazepam 7(6.3%) belonged to Category 1. According to

Table 1: Prevalence of inappropriate medicines using Beer's Criteria 2019.

Beer's Criteria components	No. of PIMs (*n*=111)	Percentage (%)	Prevalent drug	Frequency	Percentage of total PIMs (%)
Drugs to be avoided (Category 1).	78	70.27	Glimepiride	18(23.08%)	16.2
			Alprazolam	10(12.82%)	9
			Lorazepam	7(8.98%)	6.3
			Amitriptyline	5(6.41%)	4.5
			Hydroxyzine	5(6.41%)	4.5
			Quetiapine	4(5.13%)	3.6
			Prazosin	4(5.13%)	3.6
			Glibenclamide	3(3.85%)	2.7
			Clonidine	3(3.85%)	2.7
			Clonazepam	3(3.85%)	2.7
			Zolpidem	3(3.85%)	2.7
			Others	13(16.64%)	11.7
Drug-disease/ syndrome interaction (Category 2).	5	4.5	Aspirin	2(40%)	1.8
			Amitriptyline	2(40%)	1.8
			Trihexyphenidyl	1(20%)	0.9
Drug-drug interaction (Category 4).	21	18.92	Tramadol+Alprazolam	7(33.33%)	63
			Tramadol+Pregabalin	2(9.52%)	1.8
			Butorphanol+Alprazolam	1(4.76%)	0.9
			Others	11(52.36%)	9.9
Based on kidney function (Category 5).	7	6.31	Ranitidine	2(28.5%)	1.8
			Gabapentin	1(14.3%)	0.9
			Tramadol	1(14.3%)	0.9
			Enoxaparin	1(14.3%)	0.9
			Amiloride	1(14.3%)	0.9
			Spironolactone	1(14.3%)	0.9
				Frequency n=125(6.51%)	
Drugs to be used with caution (Category 3).			Tramadol	41(31.8%)	
			Furosemide	21(16.8%)	
			Aspirin	20(16%)	
			Torsemide	13(10.40%)	
			Hydrochlorothiazide	7(5.60%)	
			Mannitol	5(4.0%)	
			Quetiapine	3(2.40%)	
			Haloperidol	3(2.40%)	
			Amitriptyline	3(2.40%)	
			Others	9(7.2%)	

the study conducted by Alshammari *et al.* the most prevalent potentially inappropriate medications were PPIs (27.7%), diuretics (21.5%), anti-psychotic agents (9%), SSRI (5%), and methyldopa (4%) which includes drugs from every category. This study is in contrast with our study because the study conducted by Alshammari *et al.* has included all the five categories to be inappropriate whereas in our study drugs to be used with caution (Category 3) are exempted and are not considered to be inappropriate.[9]

Potential drug-disease/syndrome interactions were 5(4.5%) of the total identified PIMs. Subjects with CKD who were prescribed aspirin and those with fractures prescribed with amitriptyline respectively accounted for 2(1.8%) followed by subjects with BPH who were prescribed trihexyphenidyl resulted in 1(0.9%).

Table 2: Predictors of PIM and Prevalence using Beer's Criteria 2019.

Variable		Total subjects	No. of patients prescribed with PIMs	Prevalence (%)	Pearson Chi-Square	*P* value	Likelihood Ratio	*P* value
		159	69	43.39				
Age	65-75 75-84 ≥85	125 22 12	59 8 2	47.2 36.36 16.66	4.670	0.097	5.090	0.078
Gender	Female Male	72 87	23 46	31.94 52.8	7.025	0.008	7.110	0.008
Length of stay	≤5 6-10 11≥	68 63 28	28 27 14	41.17 42.85 50	0.641	0.726	0.637	0.727
Poly-pharmacy	<5 ≥5	29 130	9 60	31.03 46.27	2.207	0.137	2.267	0.132
No. of diagnosis	1 2 ≥3	15 34 110	4 13 52	26.66 38.23 47.27	–	–	–	–

Table 3: Correlation between Polypharmacy and Variables.

Variables		Total no. of participants (*n*=159)		No. of patients prescribed with potentially inappropriate medications (*n*=69)		Prevalence of polypharmacy (%)	
		<5	≥5	<5	≥5	<5	≥5
Age	65-74 75-84 ≥85	23 3 3	102 19 9	8 1 0	51 7 2	34.78 33.33 0	50 36.84 22.22
Gender	Male Female	15 14	72 58	8 1	38 22	53.33 7.14	52.78 37.93
Length of stay	≤5 6-10 11≥	17 9 3	51 54 25	6 1 2	22 26 12	35.29 11.11 66.67	43.13 48.15 48
No. of diagnosis	1 2 ≥3	4 9 16	11 25 94	0 2 7	4 11 44	0 22.22 43.75	36.36 44 47.87

Table 4: Physician's response to the suggestions provided.

Suggestions	Accepted	No response	Percentage (%)
Drugs to be avoided.	8	7	53.33
Drugs-disease interaction.	6	9	40
Drugs to be used with caution.	5	10	33.33
Drug-drug interaction.	4	11	26.67
Dosage adjustment based on renal function.	8	7	53.33
To conduct specific laboratory test (creatinine clearance).	7	8	46.67

According to the study conducted by Osei *et al.* 20.3% accounted for drug-disease/syndrome interactions. The difference between percentages in the studies is because study conducted by Osei *et al.* used 2012 Beer's Criteria which had only 3 categories whereas in our study 2019 update which contains 5 categories were utilized.[10]

Drugs to be used with caution 125 (6.51%) are exempted as PIMs because they can be used but continuous monitoring is required to assess the inappropriateness. Tramadol 41 (32.8%) followed by furosemide 21 (16.8%) and aspirin 20 (16%) were most commonly prescribed drugs of this class whereas the study conducted by Al-Azayzih A *et al.* reported that the majority of drugs to be used with caution were diuretics (45.1%), aspirin for primary prevention of cardiac events among older adults aged ≥80 years (38.8%) and vasodilators (12.3%). The variation between the studies is due to the classification of diuretics in our study.[11]

Drug-drug interactions accounted for 21(18.92%) of total PIMs which is the second highest class containing PIMs. Almost 7 (6.3%) of the detected interactions were between tramadol (opioid) and alprazolam (benzodiazepine) followed by tramadol and pregabalin 2(1.8%). A comparable study conducted by Khamis *et al.* reported that 1.7% accounted for drug-drug interactions during hospital stays.[4]

Drugs to be avoided or have their dosage adjusted based on varying levels of kidney function in older adults have contributed to almost 7(6.31)% of total PIMs tracked. Prescribing ranitidine 2(1.8%) when CrCl <50 mL/min was liable for the majority of PIMs in this class followed by gabapentin 1 (0.9%) and tramadol 1(0.9%). The study conducted by Widyaningrum *et al.* showed that the most common drug from this class was gabapentin followed by colchicine and ranitidine.[12]

Various factors can lead to the difference in the prevalence of PIM in different countries and among those factors are demographic characteristics of patients, disease status of the patient, difference in prescribing patterns, lack of clinical pharmacist and medication service management services, polypharmacy, sample size and drugs that are being marketed.

According to the demographics of the studied population, the mean age was 70.92 years. Our findings have demonstrated that 69(43.39%) subjects were prevalent to PIMs out of which 59(47.2%) were from the age group of 65-74 years. This study showed that the prevalence of PIMs has declined with age. This is because more number of participants were from the age group between 65-74 years (55%).

In our study, males 46(52.8%) were predominant to PIMs. Another study that was conducted by Yeon-Jung Lim *et al.* showed that females (58.8%) were more predominant to PIMs which is in contrast to our study.[1] This may be due to either male predominance or the fact that the most commonly prescribed PIM was glimepiride given for diabetes mellitus which is one of the most common comorbidities in our study. The study conducted by J Clin Endocrinol Metab *et al.* states that men are almost twice as likely to develop T2DM as women.[13] Gender was found to be a predictor of getting PIMs in our study because the difference between the 2 groups was statistically significant (p=0.008).

The results showed the highest prevalence of PIMs for the group with ≥11 days in the hospital stay 14 (50%) followed by 6-10 days stay in the hospital 27 (42.85%) and the lowest prevalence for patients with ≤5 days stay in the hospital 28 (41.17%). The mean duration of hospitalization was 7.27 days (SD=4.8 range 1-31). This indicates that the prevalence of PIMs increases with the length of hospital stay. The study conducted by Sharma *et al.* reported that the median length of hospital stay was 6 days and observed that with increase in hospital stay can increase in number of PIMs on the prescription.[14]

In view of prevalence of PIMs, 60 (46.15%) participants were found to be prescribed ≥5 drugs whereas 9 (31.03%) prescriptions contained <5 drugs. Accordingly, Bhagavathula et al. conducted a study where 9391 participants reported a prevalence of polypharmacy among older adults. The pooled prevalence of polypharmacy in India after weighing the regional population was 49%.[15]

The highest prevalence of PIMs was observed in the group with ≥3 diagnoses 52 (47.27%) followed by 2 diagnoses 13 (38.23%) and least prevalence for 1 diagnosis 4 (26.66%). On average, each patient had four diagnoses with a range of 1-11. Similarly, a study conducted by Sharma *et al.* reported that on average, each patient was found to have 3 diagnoses with a range of 1-9. Most of the participants 62.5% (n=202) had ≥3 diagnoses, and 24.5% (n=79) and 13% (n=42) had 2 diagnoses simultaneously and a single diagnosis respectively.[14]

It is noted that the majority of patients were primarily admitted under the Department of General Medicine 70 (44.03%) followed by Surgery 28 (17.61%). A similar study conducted by Shah *et al.* shows that out of 400 patients, 25.5% were from general medicine followed by surgery 16.25%.[16]

Physician's response to suggestions provided

The number of physicians who accepted the recommendations wasn't very high. This might be due to various reasons, such as the fact that suggestions were given without alternative options. Furthermore, since the recommendations were made by fifth-year pharmacy students, physicians might regard the students' knowledge as inferior compared to their own.

The updated criteria should be considered as a guideline for identifying drugs where the risks of their use in older adults outweigh the benefits. This update highlights numerous strengths, including the use of an evidence-based approach using the Institute of Medicine standards and the development of a

partnership to regularly update the criteria. Careful application of the criteria will allow for closer monitoring of drug use and interventions to decrease ADEs in older adults and better patient outcomes.

Strategies to overcome the prescription with PIMs and further improving care for older patients may include clinical pharmacists conducting regular medication chart reviews, awareness activities such as workshops and seminars. Also computerized interventions to reduce PIMs based on newly released guidelines may be helpful in hospital settings.[4]

Further studies should be conducted at the national level to increase awareness regarding inappropriate prescribing among elderly patients and it is also important to trace readmission in geriatrics, particularly to follow up medications that are to be used with caution (Category 3). Future research should also analyze physician's response to suggestions provided more deeply because it can be helpful in fostering a positive working relationship between physicians and pharmacists which will enhance patient care.

This study has some limitations. Certain clinical indicators (CrCl) were not available. Since these parameters are required to assess Category 5 from Beer's Criteria, their association with PIMs were not evaluated. However, we investigated all those on regular maintenance dose with varying kidney functions. It was challenging as the Beer's Criteria did not provide a dose limit for these drugs. This study only estimated the rate of physician's response and did not involve the reason behind it. Finally, all identified PIMs are not conclusive without clinical judgment, the Criteria serve only as a warning light to raise attention to clinical evaluation that further assesses risks and benefits associated with these PIMs.

CONCLUSION

This study assessed inappropriateness in prescription based on Beer's Criteria. This study concludes that the prevalence of PIMs among geriatric patients is 43.39%. Some predictors have been identified in association with the occurrence of potentially inappropriate medications. The physician's response was influenced by the suggestions provided. There is a need to raise awareness among physicians about Beer's Criteria so that they can deliver justifiable health care to the sick population. Regulatory authorities should also take action to mandate the implementation of the Beer's Criteria. This study also concludes that the CrCl rate should be taken into account when prescribing medicine for geriatrics. It is important to remember that the criteria are not absolute, but instead are intended to guide clinical decision-making.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

ABBREVIATIONS

AGS: American Geriatric Society; **PIM:** Potentially Inappropriate Medication; **ADE:** Adverse Drug Events; **CrCl:** Creatinine Clearance; **T2DM:** Type 2 Diabetes Mellitus; **CKD:** Chronic Kidney Disease; **BPH:** Benign Prostatic Hyperplasia.

SUMMARY

This study focuses on analyzing the geriatric prescriptions using Beer's Criteria and concludes that the prevalence of PIMs among geriatric patients is 43.39%. Physiological changes that occur in elderly individuals may make certain medications inappropriate, particularly those that are metabolized by the liver and kidneys or for those with other co-morbidities, even though they once were considered appropriate. Therefore there is a need to raise awareness among physicians about Beer's Criteria so that they can deliver justifiable health care to the sick population.

AUTHORS' CONTRIBUTIONS

NF, AH, and SC conceived the study and conducted the literature search. AH, NF, SC, and VM developed the methodology and participated in data analysis. SC, NF, and AH assisted in interpreting the results and contributed to the study design. All authors collaborated on drafting the manuscript and approved the final version.

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