INTERNATIONAL JOURNAL
OF
PHARMACEUTICAL SCIENCES
AND
RESEARCH

A CROSS-SECTIONAL STUDY ON POLYPHARMACY IN ELDERLY PATIENTS AT A TERTIARY CARE HOSPITAL OF TRIPURA

Shubhaleena Debnath [1], Prithul Bhattacharjee [2], Lakshman Das [* 2], Debasree Bhaumik [2], Ranjib Ghosh [2] and Arindam Datta [2]

Agartala Government Medical College & GB Pant Hospital [1], Agartala - 799006, Tripura, India.
Department of Pharmacology [2], Tripura Medical College & Dr. BRAM Teaching Hospital, Agartala - 799014, Tripura, India.

Correspondence to Author:
Dr. Lakshman Das

Associate Professor,
Department of Pharmacology,
Tripura Medical College & Dr.
BRAM Teaching Hospital, Hapania,
Agartala - 799014, Tripura, India.

E-mail: doctorldas@gmail.com

ABSTRACT: Background: There is a significant link between polypharmacy and the emergence of adverse effects, drug interactions, and increased mortality among elderly patients. Polypharmacy and inappropriate prescription are matters of concern in elderly individuals; therefore, this study was done to find the pattern of polypharmacy among elderly patients. **Methodology:** A cross-sectional study was carried out at Tripura Medical College & Dr. B. R. Ambedkar Memorial Teaching Hospital (TMC) for a period of 12 months for elderly patients. Polypharmacy was analyzed by counting the number of medications per prescription. Each prescription drug was analyzed for overprescription, under-prescription, and inappropriateness individually. Baseline data were represented by suitable tables & figures and expressed in frequency, percentage, mean & standard deviation. The Chi-square test was applied to find out any statistical association. P value < 0.05 was considered statistically significant. **Results:** 444 elderly (65 years & above) patients attending medicine OPD were interviewed individually. Our study showed that 36.93% of the patients were receiving polypharmacy. There was a significant association between overprescription or underprescription and comorbidities like diabetes, hypertension with diabetes, and other comorbidities. About 23.87% of patients received an inappropriate prescription. As per MAI criteria, significant inappropriateness was found in prescriptions with chronic kidney disease. **Conclusion:** The study can help in judicious selection of drugs while prescribing for the elderly individual in order to prevent the ill effects of polypharmacy.

INTRODUCTION: India's population aged 60 years & above is projected to increase over the next decade [1]. An estimated 50% of elderly people in India suffer from at least one chronic disease that requires lifelong medication [2]. Conventionally, "elderly" is defined as a chronological age of 65 or older [3].

Older adults suffer from multiple comorbidities and seek medical advice from different physicians simultaneously. They are also the highest consumer of drugs. As a result, there is an increased chance of polypharmacy. Above all, there are declines in immunity and age-related physiological changes in this age group [4].

All these factors lead to adverse drug reactions (ADRs) in the elderly. According to World Health Organization (WHO) polypharmacy is defined as 'the administration of many drugs at the same time or the administration of an excessive number of drugs [5]. Polypharmacy is considered if the patient

receives five or more concurrent medications [6]. Overuse of medication carries major health risks, especially among the elderly. There is a significant link between polypharmacy and the emergence of adverse effects, drug interactions, and increased mortality [7]. Polypharmacy often makes patients confuse trying to remember the drug regimen & leads to poor compliance as well as wastage of money. Some drugs pose special risks to older people, for example, prolonged sedation and increased risk of falls with long-acting benzodiazepines or increased risk of upper gastrointestinal bleeding with nonsteroidal anti-inflammatory drugs (NSAIDs) [8].

Prescriptions of such drugs are potentially inappropriate. Potentially inappropriate medications (PIMs) are considered when drugs outweigh the risk of an adverse event over their clinical benefit, particularly when there are safer or more effective alternative therapies for the same condition. The causes which lead to inappropriate prescribing may be lack of updated knowledge, imprecise diagnosis, patient overload, unrealistic claims by manufacturers, patients' demand *etc.* [9]. The use of PIMs is common in elderly patients & is often associated with increased morbidity & mortality, increased cost, and decreased quality of life [5]. Though polypharmacy and inappropriate prescription are matters of concern, few literatures are available in the northeastern states of India. In this study, the polypharmacy pattern and prescription appropriateness were evaluated in elderly patients at Tripura Medical College & Dr. B.R. Ambedkar Memorial Teaching Hospital (TMC).

Aim & Objectives:
AIM: To study the pattern of polypharmacy among elderly patients.

Objectives:

1. To find out the distribution of comorbidities among different age groups in elderly patients.

2. To assess the association between comorbidities and polypharmacy.

3. To determine the appropriateness (overprescribing, underprescribing, and inappropriate prescribing) of prescriptions among the study population.

MATERIALS AND METHODS:
Study Design: Cross-sectional study.

Study Area: TMC

Study Setting: Medicine out Patient Department (OPD) and Department of Pharmacology.

Study Period: 12 months.

Study Population: Elderly patients of 65 years & above.

Sample size: Sample size is calculated based on the expected proportion of people aged 65 years & above receiving polypharmacy as 52% as per previous studies [6, 35]. Taking 10% as relative precision at 90% power and confidence level of 95%, the sample size is found to be 355. Adding 20% as non-responders, the final sample size is 444 geriatric patients.

Inclusion Criteria: Both male and female patients aged 65 years and above attending medicine OPD were included in the study.

Exclusion Criteria: Herbal medicines were excluded for analyzing their appropriateness, as they are not included in any of the standard criteria.

Study Tools & Techniques:
Study Tools: To assess polypharmacy, number of drugs per prescription was counted. Polypharmacy was considered if the patient receives five or more concurrent medications [5, 9, 10, 17].

- To assess the appropriateness of prescription in elderly following criteria were used -

Beers Criteria (2015 Version) [19]: It contains fifty-three (53) inappropriate medications/medication classes, which are divided into five categories as follows:

1. Criteria for PIM use in older adults.

2. Criteria for PIM use in older adults due to drug-disease or drug-syndrome interactions that may exacerbate disease

3. Criteria for PIMs to be used with caution in elderly.

4. Criteria for potentially clinically important non-anti-infective drug-drug interactions that should be avoided in elderly.

5. Criteria for non-anti-infective medications that should be avoided or need dose adjustment according to kidney function.

Screening Tool of Older Person's Prescriptions (STOPP) Criteria [20]: It has 65 criteria categorized under different physiological systems & gives information regarding drugs to be avoided in certain conditions.

Screening Tool to Alert to Right Treatment (START) Criteria [20]: It includes 23 criteria under various physiological systems & focuses on drugs to be prescribed for certain conditions.

Medication Appropriateness Index (MAI) [36]: It consists of 10 questionnaire scales with scores from 0-3.

1. If a drug is 'Appropriate' or 'marginally appropriate, 'a score of zero is given to that drug. Each of the 10 criteria of the MAI that is considered 'Not appropriate' is given a maximum score of 1, 2 or 3 for each drug.

2. Weight of three is given for indication and effectiveness.

3. Weight of two is assigned to dosage, correct directions, practical directions, and drug-drug interactions.

4. One weight is assigned to drug-disease interactions, expense, duplication, and duration.

5. This, therefore, results in a total combined score of 0 to 18 (0 meaning the drug is appropriate and 18 representing maximal inappropriateness).

6. Combining the total MAI scores for each prescribed drug will yield a score for each patient.

7. The total score per patient will depend on the number of drugs a patient is on. For example, if a patient is on one drug, the minimum score would be 0, and the maximum score is 18; whilst if the patient is on 2 drugs, the minimum score per patient is 0 with a maximum inappropriateness of 36.

Study Technique: The study was conducted after obtaining informed written consent from each patient in their language. Each patient was interviewed individually, and all the relevant information about the prescription was recorded in a predesigned proforma. Polypharmacy was analyzed by counting the number of medications per prescription. Drug combinations were considered as a single drug. Each prescription drug was individually analyzed for overprescription by Beers and STOPP, under prescription by START and inappropriate by MAI criteria, and was considered appropriate or inappropriate. After analyzing all the individual drugs of a prescription, if any of the drugs come out as unfitting to any of the criteria, the prescription was considered inappropriate.[23] If a prescription becomes appropriate by using one criteria, it may be considered inappropriate by another criterion. Moreover, one prescription can be inappropriate by more than one criterion also.

Ethical Approval: - Ethical Approval was obtained from the Institutional Ethics Committee as per notification No.F.3 (PO-75)/Inst. Ethical Com./SFTMC/2010-11/11365-11377.

Confidentiality: - Was strictly maintained for each individual patient.

Statistical Analysis: - Data was entered in an excel sheet and analyzed using SPSS (Statistical Package for Social Sciences) version 20. Baseline data were represented by suitable tables & figures and expressed in frequency, percentage, mean & standard deviation. The Chi-square test was applied to find out any statistical association. P value < 0.05 was considered statistically significant.

RESULTS:

Distribution of Study Population: A total of 444 patients were included in the study. Among them, 273 (61.5%) were males & 171 (38.5%) were females. Gender and age group-wise distribution are shown in **Table 1.**

TABLE 1: DISTRIBUTION OF STUDY POPULATION ACCORDING TO GENDER AND AGE [N = 444]

Gender	Category	Frequency (%)	
		Female	**Male**
		171 (38.5)	273 (61.5)
Age (in years)	65-70		256 (57.7)
	71-80		136 (30.6)
	81-90		41(9.2)
	>90		11(2.5)

Distribution of Comorbidities: The distribution of comorbidities according to the different age group is shown in **Table 2**. Out of 444 patients, a total 212 patients were suffering from various comorbid conditions like hypertension, diabetes, hypertension with diabetes, chronic kidney disease (CKD) & others. Others include anaemia, atrial fibrillation, autoimmune hepatitis, benign hypertrophy of prostate (BPH), coronary artery disease, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), cerebrovascular disease (CVA), dyslipidaemia, dyspepsia, hypothyroidism, liver diseases, osteoarthritis, parkinsonism, tuberculosis & valvular defect.

Hypertension was found to be the commonest comorbidity which was seen in 92 (43.40%) patients. Among these 92 patients, 51(55.40%), 31(33.70%), 5(5.40%), and 5(5.40%) patients were from the age groups of 65-70 years, 71-80 years, 81-90 years and above 90 years respectively.

Diabetes was present in 30 (14.20%) patients, of which 21(70%) patients were between 65-70 years age and 9 (30%) patients were between 71-80 years age. No patients above the age of 80 years had only diabetes as a comorbid condition. There were 31(14.60%) patients having both hypertension and diabetes as a comorbidity. Among them 18 (58%), 11 (35.60%) & 2 (6.40%) patients belong to 65-70 years, 71-80 years, 81-90 yearsand none from more than 90 years age group.A total 12 (5.60%) patients had chronic kidney disease & the age group wise distribution was 04 (33.30%) number of patients in each age group of 65-70 years, 71-80 years, 81-90 years and none above 90 years. 47(22.20%) out of 212 patients were suffering from other comorbidities. The number of patients in different age group were 27 (57.40%), 14 (29.80%), 3 (6.40%) & 3 (6.40%) in 65-70 years, 71-80 years, 81-90 years and above 90 years age group respectively.

TABLE 2: DISTRIBUTION OF COMORBIDITIES ACCORDING TO AGE GROUP [N =212]

Comorbidities	Total no (%)	Age category (in years)			
		65-70[n=121]	71-80 [n=69]	81-90[n=14]	>91[n=08]
HTN	92 (43.40)	51(55.40)	31(33.70)	5(5.40)	5(5.40)
DM	30 (14.20)	21(70.00)	09 (30.00)	0 (0)	0 (0)
HTN + DM	31(14.60)	18(58.00)	11(35.60)	2(6.40)	0(0)
CKD	12(5.60)	04(33.30)	04(33.30)	04(33.30)	0(0)
Others	47 (22.20)	27(57.40)	14(29.80)	3(6.40)	3(6.40)

The figures in parentheses indicate percentages.

Distribution of Drug(s) Per Prescription: Table 3 shows drug(s) distribution per prescription. A total 1862 number of drugs were prescribed among 444 prescriptions. A minimum one and maximum nine drugs were prescribed in a single prescription.

There were 06 (1.4%) prescriptions with a single drug. A number of prescriptions having two and three drugs were 65 (14.6%) and 99 (22.2%), respectively. Majority of prescriptions had four number of drugs which was found to be 110 (24.8%) out of 444 prescriptions. There were 80 (18%), 40 (9%), and 12 (2.7%) numbers of prescriptions containing five, six and seven drugs, respectively.

Some of the prescriptions contained even up to eight & nine number of drugs and their frequency were 13 (2.9%) and 19 (4.3%), respectively. Average number of drug per prescription was found to be 4.2.

TABLE 3: DISTRIBUTION OF DRUG(S) PER PRESCRIPTION [N = 444]

No of drug (s) per prescription	Frequency (%)
1	6 (1.4)
2	65 (14.6)
3	99 (22.2)
4	110 (24.8)
5	80 (18.0)
6	40 (9.0)
7	12 (2.7)
8	13 (2.9)
9	19 (4.3)

Distribution of Prescriptions with Polypharmacy: The distribution of polypharmacy according to the age category was shown in **Table 4.** 164 (36.93%) out of 444 patients received polypharmacy, *i.e.*, five or more drugs in a prescription.

94 (57.32%) patients receiving polypharmacy were between 65 and 70 years old. The remaining 45 (27.44%), 18 (10.98%), and 7 (4.26%) geriatric

patients belonged to the age groups 71-80 years, 81-90 years, and above 90 years, respectively. We found 280 (63.07%) patients who did not receive polypharmacy in their prescriptions. Out of 280 patients, 163 (58.21%) patients belonged to 65-70

years, 91 (32.50%) patients belonged to 71-80 years, 22 (7.86%) patients belonged to 81-90 years & 4 (1.43%) patients belonged to above 90 years of age group.

TABLE 4: DISTRIBUTION OF PRESCRIPTIONS WITH POLYPHARMACY ACCORDING TO AGE GROUP [N = 444]

Prescriptions with polypharmacy	Total no of prescriptions (%)	Age category(in years)			
		65–70	71–80	81–90	≥90
Yes	164(36.93)	94(57.32)	45(27.44)	18(10.98)	7(4.26)
No	280(63.07)	163(58.21)	91(32.50)	22(7.86)	4(1.43)

The figures in parentheses indicate percentage.

Association between Comorbidities and Polypharmacy: One of the objectives of this study was to find the association between comorbidities and polypharmacy shown in **Table 5** & **Fig. 1**. The Chi-square test was applied to find out this association. Out of total 444 patients, 92 (20.73%) patients were hypertensive, and the remaining 352 (79.27%) patients were non-hypertensive as single comorbidity. It was observed that 34 (36.95%)

hypertensive patients and 109 (30.96%) non-hypertensive patients received polypharmacy. On the other hand, 58 (63.05%) hypertensive patients and 243 (69.03%) non-hypertensive patients did not receive polypharmacy. Though polypharmacy was more in hypertensives than non-hypertensives, no significant association was found between hypertension as comorbidity & polypharmacy (P= 0.27).

TABLE 5: ASSOCIATION BETWEEN COMORBIDITIES AND POLYPHARMACY [N=444]

Comorbidities	Total	Receiving polypharmacy		P value
		Yes	No	
HTN				
Yes	92	34 (36.95)	58 (63.05)	0.27
No	352	109 (30.96)	243 (69.03)	
DM				
Yes	30	12 (40)	18 (60)	0.04*
No	414	97 (23.43)	317 (76.57)	
HTN + DM				
Yes	31	22 (70.97)	09 (29.03)	0.001*
No	413	87 (21.07)	326 (78.93)	
CKD				
Yes	12	12 (100)	00 (00)	-
No	432	97 (22.45)	335 (77.55)	
Others				
Yes	47	29 (61.70)	18 (38.30)	0.001*
No	397	80 (20.15)	317 (79.85)	

The figures in parenthesis indicate percentages. *P < 0.05 taken as statistically significant based on the Chi-square test.
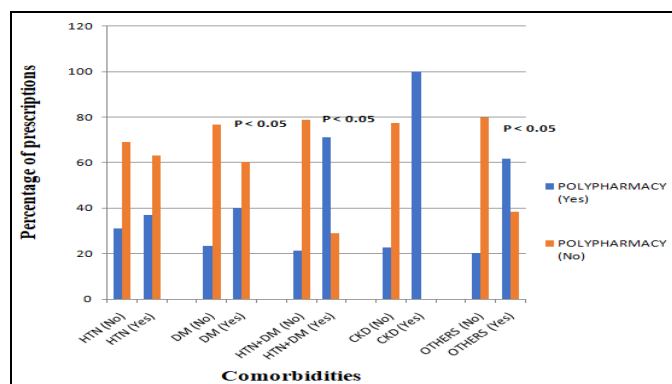
FIG. 1: ASSOCIATION BETWEEN COMORBIDITY & POLYPHARMACY

Out of 30 diabetic patients (as single comorbidity) 12 (40%) patients received polypharmacy. Whereas among 414 non-diabetic patients, polypharmacy was received by 97 (23.43%) patients. Thus, patients with diabetes received more polypharmacy than patients without diabetes. A statistically significant association was found between diabetes as comorbidity & polypharmacy (p = 0.04). 31 patients had both hypertension and diabetes as a comorbidity. 22 patients among them received polypharmacy and 9 patients didn't receive

polypharmacy. The presence of both hypertension and diabetes was significantly associated with polypharmacy (p=0.001). All 12 patients suffering from chronic kidney disease (CKD) as comorbidity received polypharmacy. Forty-seven patients were suffering from other comorbidities like anaemia, atrial fibrillation, autoimmune hepatitis, benign hypertrophy of the prostate (BPH), coronary artery disease, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), cerebrovascular disease (CVA), dyslipidemia, dyspepsia, hypothyroidism, liver diseases, osteoarthritis, parkinsonism, tuberculosis & valvular defect. Among them, 29 patients received polypharmacy, and 18 didn't, which again showed a significant association with polypharmacy with a p-value of 0.001.

Proportion of Patients Receiving Overprescription and Underprescription: Overprescriptions were analyzed by Beers & STOPP criteria and underprescription by START criteria. Out of total 444 prescriptions, 178 (40.10%) prescriptions were overprescribed, and 9 (2.02%) prescriptions were underprescribed. A total 187 (42.12%) prescriptions were inappropriate (over and underprescribed). The remaining 257 (57.88%) prescriptions were appropriate as per

Beers, STOPP & START criteria. All 187 inappropriate prescriptions were again analyzed according to various comorbidities. The distribution of overprescription & underprescription about various comorbidities are shown in **Table 6.** Association between in appropriateness of prescriptions (overprescription & under-prescription) and comorbidities were also analyzed & the data are displayed in **Table 7** & **Fig. 2**. Out of 92 prescriptions of hypertension, a total 40 (43.47%) prescriptions were inappropriate and the remaining 52 (56.52%) prescriptions were appropriate. On the other hand, out of 352 prescriptions without hypertension (as single comorbidity) 205 (58.24%) prescriptions were appropriate & 147 (41.76%) prescriptions were inappropriate.

No statistical significance was found between prescriptions with hypertension (as single comorbidity) & their appropriateness (P=0.766). Similarly, there was no statistical significance between prescriptions with chronic kidney disease (CKD) & their appropriateness (P=0.08). Among 30 prescriptions with diabetes, 25 prescriptions were considered appropriate, which was statistically significant (P = 0.001).

TABLE 6: PATIENTS RECEIVING OVERPRESCRIPTION AND UNDERPRESCRIPTION

Comorbidities	Total No	Overprescription (as per Beers and STOPP criteria) and underprescription (as per START criteria)		
		Over prescription (%)	Under prescription (%)	Over prescription + Under prescription (%)
Hypertension	92	39 (42.39)	01 (1.08)	40 (43.47)
Diabetes	30	05 (16.67)	00 (0)	05 (16.67)
HTN + DM	31	25 (80.65)	01 (3.22)	26 (83.87)
CKD	12	08 (66.67)	00 (0)	08 (66.67)
Others	47	26 (55.32)	03 (6.38)	29 (61.70)
Without comorbidity	232	75 (32.33)	04 (1.72)	79 (34.05)
Total	444	178 (40.10)	09 (2.02)	187 (42.12)

TABLE 7: ASSOCIATION OF OVERPRESCRIPTION & UNDERPRESCRIPTION WITH COMORBIDITIES

Comorbidities	Total	Appropriateness (neither overprescribed nor underprescribed) as per Beers, STOPP & START criteria		P value
		Yes	No	
HTN				
Yes	92	52 (56.52)	40 (43.48)	0.766
No	352	205 (58.24)	147 (41.76)	
DM				
Yes	30	25 (83.33)	05 (16.67)	0.001*
No	414	232 (56.04)	182 (43.96)	
HTN + DM				
Yes	31	05 (16.13)	26 (83.37)	0.001*

No	413	252 (61.02)	161(38.98)	
CKD				
Yes	12	04 (33.33)	08 (66.67)	0.08
No	432	253 (58.56)	179 (41.44)	
Others				
Yes	47	18 (38.30)	29 (61.70)	0.001*
No	397	239 (60.20)	158 (39.80)	
Without comorbidity				
Yes	232	153 (65.95)	79 (34.05)	0.001*
No	212	104 (49.06)	108 (50.94)	

The figures in parentheses indicate percentages. *P < 0.05 taken as statistically significant based on the Chi-square test.

On the other hand, 26 prescriptions having both hypertension & diabetes were considered inappropriate of 31 prescriptions which were statistically significant (P = 0.001). Out of 47 prescriptions with other comorbidities, 29 prescriptions were also inappropriate (P = 0.001). There were 232 prescriptions without any comorbidities. Among them, 153 prescriptions were appropriately prescribed which was statistically significant (P = 0.001).
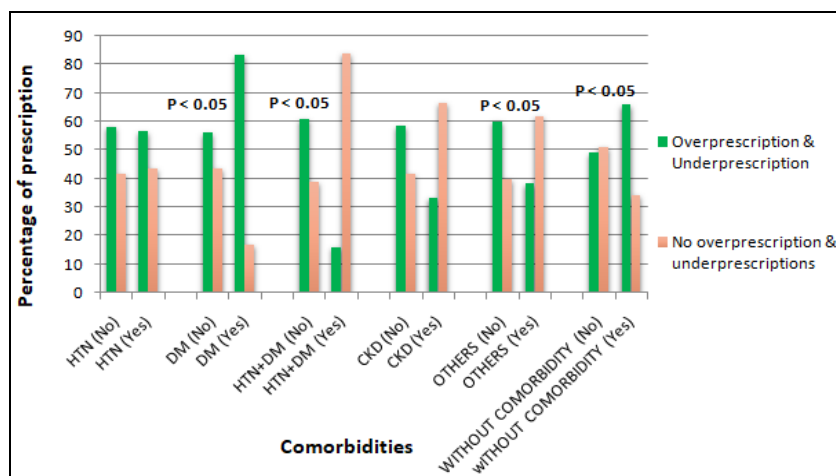

FIG. 2: ASSOCIATION OF OVERPRESCRIPTION & UNDERPRESCRIPTION WITH COMORBIDITIES

Appropriateness of Prescription: Appropriateness of prescriptions by MAI criteria was evaluated separately. The distribution of appropriateness according to comorbidity is shown in **Table 8** & **Fig. 3**. Out of all patients, 212 patients were suffering from various comorbidities, as mentioned earlier in **Table 8** & remaining 232 patients were without any comorbid condition. Among all patients, 106 (23.87%) patients received inappropriate and 338 (76.13%) received appropriate prescriptions.

TABLE 8: APPROPRIATENESS OF PRESCRIPTION (AS PER MAI CRITERIA)

Comorbidities	Total	Appropriateness as per MAI		P value
		Yes	No	
HTN				
Yes	92	67 (72.83)	25 (27.17)	0.31
No	352	271(76.99)	81 (23.01)	
DM				
Yes	30	27 (90.0)	03 (10.0)	0.06
No	414	311(75.12)	103 (24.88)	
HTN + DM				
Yes	31	23 (74.20)	08 (25.80)	0.79
No	413	315(76.27)	98 (23.73)	
CKD				
Yes	12	03 (25.0)	09 (75.0)	0.001*
No	432	335(77.55)	97 (22.45)	
Others				

Yes	47	33 (70.21)	14 (29.79)	0.31
No	397	305(76.83)	92 (23.17)	
Without comorbidity				
Yes	232	185(79.74)	47 (20.26)	0.06
No	212	153(72.17)	59 (27.83)	

The figures in parentheses indicate percentages. *P < 0.05 taken as statistically significant based on the Chi-square test.
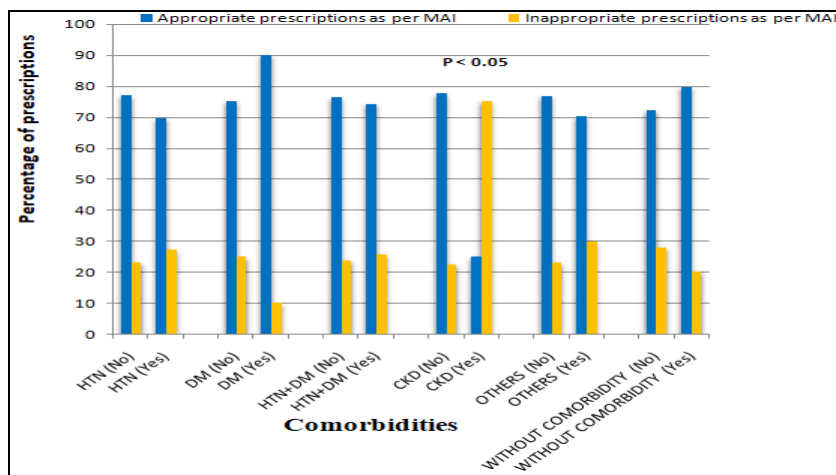

FIG. 3: APPROPRIATENESS OF PRESCRIPTION (AS PER MAI CRITERIA)

Among 92 prescriptions with hypertension, 25 (27.17%) were inappropriate & 67 (72.83%) were appropriate. 352 patients were not suffering from hypertension as single comorbidity; among them, 81 (23.01%) received inappropriate & 271 (76.99%) received appropriate prescriptions. No significant association was found between prescriptions with hypertension & their appropriateness (P=0.31). Similarly, prescriptions with diabetes (as single comorbidity), hypertension with diabetes, and other comorbidities did not show any significant correlation with their appropriateness. Chronic kidney disease was seen in 12 patients. Out of that, 09 patients received significantly inappropriate prescriptions (P=0.001). No significant association was also found between prescriptions without any comorbidity with their appropriateness (P= 0.06).

DISCUSSION: The present study evaluated the polypharmacy and appropriateness of prescriptions in geriatric patients attending a tertiary care hospital. In this study, polypharmacy was defined as receiving five or more medications. This study included patients aged 65 years & above, and the mean age was 71.45 ± 6.81 years. The average number of medications per prescription was 4.2. Our study showed that 36.93% of the geriatric patients were receiving polypharmacy. Among the study participants in our study, there was a male

preponderance (61.5%) compared to females (38.5%). In contrast, the distribution of gender was 54.6% male & 45.3% female in a study done by Rakesh KB *et al.*[6] Lee SJ *et al.*[22] found 55% male & 45% female participants in their study. The mean age of the patients in our study was 71.45 ± 6.81 years, whereas the mean age (in years) was 55.60 ± 13.86, 67.45 ± 6.992 & 69.37 ± 7.42 in some other studies [37, 30, 39]. Patients were suffering from various comorbidities, with hypertension being the commonest (43.40%). This is comparable to Rakesh KB *et al.*[6], which also found that hypertension was the most common comorbid condition (75.4%). Hypertension & diabetes were also found to be common comorbidities in other studies [40, 41, 42]. The prevalence of polypharmacy was 36.93% in our study, which was comparable to that of the studies done by Golchin N *et al.* (39.4%) & Slabaugh SL *et al.* (35.6%) [15, 43].

Various authors found the higher proportion of polypharmacy as 66.2%, 78%, 60% & 89%in their studies [6, 27, 31, 42]. On the other hand, some of the studies showed better prescribing patterns in terms of polypharmacy with a proportion of 13.85%, 23.1% & 26.7% [38, 39, 16]. The proportion of polypharmacy in the present study was higher in the 65-70 years age group, which was comparable to the study by Mamun K. *et al.*[31]. Some other authors showed a higher proportion of

polypharmacy in 70–79 years age group in their studies [6, 44].

One of the major causes of polypharmacy is multiple health conditions requiring the use of several medications. In our study, a significant increase in polypharmacy was associated with diabetes and hypertension with diabetes as comorbidities. Zabihi A. *et al.* [39] and Al. Ameri M. N. *et al.*[42] also found that heart diseases, diabetes & hypertension were associated with polypharmacy. The appropriateness of prescriptions was evaluated using various criteria like Beers criteria, STOPP criteria, START criteria & MAI criteria. Researchers across the world widely use these criteria. Moreover, these criteria are updated regularly. Based on the above criteria, 44.59% of prescriptions were inappropriate in our study. We found that 40.10% and 2.02% were overprescription & underprescription, respectively. 23.87% of prescriptions were inappropriate as per MAI criteria. Significant inappropriateness was found in prescriptions having hypertension with diabetes, CKD, and other (mentioned above) comorbidities. Prescriptions with diabetes as single comorbidity were found to be appropriate. Various studies have reported an inappropriateness of prescription to an extent of 32%, 53%, 62.5%, 66% and76.6% respectively [45, 46, 47, 49, 41]. About 16.89% patients received potentially inappropriate medications as per Beers criteria. Drugs like clonazepam, tramadol, amitriptyline, prazosin, digoxin, dimenhydrinate were inappropriately prescribed. The proportion of inappropriate prescriptions by AGS Beers Criteria2015 was found to be 8.45% by Rakesh KB *et al.* [6], 21.86% by Pradhan S *et al.* [23] & 63% by Kose E *et al.* [48] Serious adverse drug reactions may occur as a consequence of inappropriate medication use.

For example, long-acting benzodiazepines like clonazepam can cause cognitive impairment and increase the risk of falls in elderly [19]. In our study, 23.19% of patients received inappropriate drugs as per STOPP criteria which were in accordance with studies done by Lee SJ *et al.* [22] and O'Mahony D *et al.* [20] showing their proportion as 20.5% and 21.4%, respectively. Among all prescriptions, 2.02% of prescriptions were underprescribed as per START criteria, whereas underprescription was found to be 26.5% in the study conducted by O' Mahony D *et*

al. [20]. We found the omission of the antiplatelet agent in some patients having a history of coronary artery disease and folic acid supplement in patients receiving Methotrexate as per START criteria. About 23.87% of patients received inappropriate prescriptions as per MAI criteria. This inappropriateness was significant in prescriptions with CKD. The proportion of inappropriateness by MAI criteria is comparable (19.9%) to the finding of Rakesh KB et al.[6] This inappropriate prescription may increase the cost of therapy [34].

CONCLUSION: In this study, there was a significant association between polypharmacy & comorbidities like diabetes, hypertension with diabetes, *etc*. Hypertension was the commonest comorbid condition. Inappropriateness was found in prescriptions having hypertension with diabetes and chronic kidney disease as comorbidities. Polypharmacy & inappropriate medications are related to various negative consequences like the risk of adverse drug effects, harmful drug interactions, non-adherence, and increased cost of therapy. The study's findings indicate that drugs should be selected more judiciously while prescribed for the elderly to prevent polypharmacy's ill effects.

CONFLICTING INTEREST: None

REFERENCES:

1. Report of Technical Group of Population Projections May 2006, National Commission on Population/ MoHFW and National Health Profile 2008; MoHFW.
2. Rajan SI: The Centre for Enquiry into Health and Allied Themes (CEHAT). Population Ageing and Health in India. July 2006. Available at: http://www.cehat.org/humanrights/rajan.pdf (last accessed on January 5, 2014).
3. Orimo H and Ito H: Reviewing the definition of "elderly". GeriatrGerontol Int 2006; 6: 149-54.
4. Momin TG, Pandya RN, Rana DA and Patel VJ: Use of Potentially inappropriate medications in hospitalized elderly at a teaching hospital: A Comparison between Beers 2003 and 2012 criteria. Ind J Pharmacol 2013; 45: 603-607.
5. Monégat M, Sermet C, Perronnin C and Rococo E: Polypharmacy: Definitions, Measurement and Stakes

Involved Review of the Literature and Measurement Tests. Questionsn 2014; 02041-8.

6. Rakesh KB, Chowta MN, Shenoy AK, Shastry R and Pai SB: Evaluation of polypharmacy and appropriateness of prescription in geriatric patients: a cross sectional study at a tertiary care hospital. Ind J Pharmacol 2017; 49: 16-20.

7. Field TS, Gurwitz JH, Avorn J, McCormick D, Jain S, Eckler M and Benser M: Bates D.W. Risk factors for adverse drug events among nursing home residents. Arch Intern Med 2001; 161(13): 1629-34.

8. Sharma HL: Principles of Pharmacology. 2nd edition. Paras medical publishers 2011; 906.

9. Tripathy KD: Essentials of Medical Pharmacology. 8th edition. JAYPEE Brothers Medical Publishers 2019; 71.

10. Fillit HM, Futterman R, Orland BI, Chim T, Susnow L and Picariello GP: Polypharmacy management in medicaremanaged care: Changes in prescribing by primary care physicians resulting from a program promoting medication reviews. Am J Manag Care 1999; 5: 587-94.

11. Linjakumpu T, Hartikainen S, Klaukka T, Veijola J, Kivelä SL and Isoaho R: Use of medication and polypharmacy are increasing among the elderly. J Clin Epidemiol 2002; 55: 809-81.

12. Shah RB, Gajjar BM and Desai SV: Drug utilization pattern among geriatric patients assessed with the anatomical therapeutic chemical classification/ define daily dose system in a rural tertiary care teaching hospital. Int J Nutr Pharmacol Neurol Dis 2012; 2: 258-65.

13. Junius-Walker U, Theile G and Hummers-Pradier E: Prevalence and predictors of polypharmacy among older primary care patients in Germany. FamPract 2007; 24: 14-9.

14. Maher Jr RL, Hanlon JT and Hajjar ER: Clinical Consequences of Polypharmacy in Elderly. PMC 2014; 1-11.

15. Golchin N, Frank SH, Vince A, Isham L and Meropol SB: Polypharmacy in the elderly. Journal of Research in Pharmacy Practice 2015; 4: 85-88.

16. Harugeri A, Joseph J, Parthasarathi G, Ramesh M and Guido S: Potentially inappropriate medication use in elderly patients: A study of prevalence and predictors in two teaching hospitals. J Postgrad Med 2010; 56: 186-91.

17. Chakraborty A, Ray D, Ghosh R, Roy N and Bhattacharje S: Pattern of adverse drug reactions reporting in two medical colleges of Tripura, India: A cross sectional study. Int J Basic and Clinical Pharm 2017; 6: 1372.

18. Sharma P and Chauhan HS Gupta NL: Prevalence of polypharmacy: Comparing the status of Indian states. Indian J of Community and Family Medicine 2019; 5: 4-9.

19. American Geriatrics Society 2015 Beers Criteria Update Expert Panel. American Geriatrics Society 2015 Updated Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. J Am Geriatr Soc 2015; 63: 2227-46.

20. O'Mahony D, Gallahar P, Ryan C, Byrne S, Hamilton H, Barry P and O'Connor M: STOPP & START criteria: a new approach to detecting potentially inappropriate prescribing in old age. European Geri Med 2010; 1: 45-51.

21. Zaveri HG, Mansuri SM and Patel VJ: Use of potentially inappropriate medicines in elderly: a prospective study in medicine out-patient department of a tertiary care teaching hospital. Ind J Pharmacol 2010; 42: 95-98.

22. Lee SJ: Survey of potentially inappropriate prescription using STOPP/START criteria in Inha University Hospital. Korean J Fam Med 2013; 34: 319-26.

23. Pradhan S, Panda A, Mohanty M, Behera JP, Ramani YR and Pradhan PK: A study of prevalence of potentially inappropriate medication in elderly in a tertiary care teaching hospital in the state of Odisha. Int J Med Sci Public Health 2015; 5: 344-48.

24. Kanagasanthosh K, Topno I and Aravindkumar B: Prevalence of potentially inappropriate medication use and drug utilization pattern in elderly patients: a prospective study from a tertiary care hospital. International Journal of Research in Medical Sciences 2015; 3: 2062-72.

25. Faustino CG, Martins Mde A and Jacob-Filho W: Potentially inappropriate medication prescribed to elderly outpatients at a general medicine unit. Einstein 2011; 9: 18-23.

26. Niwata S, Yamada Y and Ikegami N: Prevalence of inappropriate medication using Beers criteria in Japanese long-term care facilities. BMC Geriatr 2006; 6: 1.

27. Borah L, Devi D, Debnath PK and Deka D: A study of drug utilization pattern of the geriatric patients in the department of geriatric medicine in a tertiary care hospital in Assam, India. Asian J Clin Pharm Res 2017; 10: 122-26.

28. Vlahovic-Palcevski V and Bergman U: Quality of prescribing for the elderly in Croatia-computerized pharmacy data can be used to screen for potentially inappropriate prescribing. Eur J Clin Pharmacol 2004; 60(3): 217-20.

29. Van der Hooft CS, Jong GW, Dieleman JP, Verhamme KM, Van der Cammen TJ and Stricker BH: Inappropriate drug prescribing in older adults: The updated 2002 Beers criteria-a population-based cohort study. Br J Clin Pharmacol 2005; 60: 137-44.

30. Naveen Kumar KL, Holyachi S, Reddy K, Nayak P and Byahatti N: Prevalence of polypharmacy and potentially inappropriate medication use among elderly people in the rural field practice area of a medical college in Karnataka. Int J Med Sci Public Health 2015; 4: 1071-75.

31. Mamun K, Lien CTC and Ang WS: Polypharmacy and inappropriate medication use in Singapore nursing homes. Ann Acad Med Singapore 2004; 33: 49-52.

32. Bajwa SJS, Sehgal R, Bajaj A, Khaira U and Kresse V: Polypharmacy and potentially inappropriate medication use as the precipitating factor in readmissions to the hospital. J of Fam Med and Primary Care 2013; 2: 194-99.

33. Ruggiero C, Dell'Aquila G, Gasperini B, Onder G, Lattanzio F and Volpato S: Potentially inappropriate drug prescriptions and risk of hospitalization among older, Italian nursing home residents: The ULISSE project. Drugs Aging 2010; 27: 747-58.

34. Fick DM, Waller JL, Maclean JR. Potentially inappropriate medication use in a medicare management care population: Association with higher costs and utilization. J Manag Care Pharm 2001; 7: 407-13.

35. Reich O, Rapold R, Rosemann T, Senn O, Blozik E. Potentially inappropriate medication use in older patients in Swiss managed care plans: prevalence, determinants and association with hospitalization. PLOS ONE 2014; 9: 1-9.

36. Hanlon JT, Schmader KE, Samsa GP, Weinberger M, Uttech KM and Lewis IK: A method for assessing drug therapy appropriateness. J Clin Epidem 1992; 45: 1045 51.

37. John NN and Kumar AN: A study on polypharmacy in senior Indian population. IJPCBS 2013; 3: 168-71.

38. Rataboli PV and Khandeparkar A: A study of harmful drug–drug interactions due topolypharmacy in hospitalized patients in Goa Medical College. Perspectives in Clinical Research 2017; 8: 180-86.

39. Zabihi A, Amiri SRJ, Hosseini SR, Bijani A. Polypharmacy among the Elderly. Journal of Mid-life Health 2018; 9: 97-103.

40. Radhika AR, Juber. S M, Nousheen N and Rahman A: Polypharmacy in elderly patients: a research article in teaching hospital. IOSR Journal of Dental and Medical Sciences 2018; 17: 16-23.

41. Khamis S, Abdi AM, Basgut B and Uzan A: Applying Beers criteria for elderly patients to assess rational drug use at a university hospital in Northern Cyprus Journal of Pharmacy and Bioallied Science 2019; 11: 133-41.

42. Al Ameri MN, Makramalla E, Albur U, Kumar A and Rao P: Prevalence of polypharmacy in the elderly: Implications of age, gender, comorbidities and drug interactions. J Pharm Pharm Sci 2014; 1: 1-7.

43. Slabaugh SL, Maio V, Templin M and Abouzaid S: Prevalence and risk of polypharmacy among the elderly in an outpatient setting: A retrospective cohort study in the Emilia-Romagna region, Italy. Drugs Aging 2010; 27: 1019-28.

44. Dutta M and Prashad L: Prevalence and risk factors of polypharmacy among elderly in India: Evidence from SAGE Data. Int J Public Ment Health Neurosci 2015; 2: 11-16.

45. Laroche ML, Charmes JP, Nouaille Y, Fourrier A and Merle L: Impact of hospitalisation in an acute medical geriatric unit on potentially inappropriate medication use. Drugs Aging 2006; 23: 49-59.

46. Sapkota S and Pudasaini N: Drug Prescribing pattern and prescription error in elderly: A retrospective study of inpatient record. Asian J Pharm Clin Res 2011; 4: 129-32.

47. Lai HY, Hwang SJ, Chen YC, Chen TJ, Lin MH, Chen LK: Prevalence of the prescribing of potentially inappropriate medications at ambulatory care visits by elderly patients coveredby the Taiwanese National Health Insurance program. Clin Ther 2009; 31: 1859-70.

48. Cartwright OM, Moulin J and Hale LS: A Retrospective Evaluation of Potentially Inappropriate Medication use in Hospitalized Elderly Patients. Proceedings of the 3rd Annual GRASP Symposium, Wichita State University 2007; 41-2.

49. Kose E, Hirai T, Seki T and Hayashi H: Role of potentially inappropriate medication use in rehabilitation outcomes for geriatric patients after strokes. Geriatr Gerontol Int 2018; 18: 321-28.