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Research Article

Assessment of Potentially Inappropriate Medications and Prescription Appropriateness in Geriatrics at Tertiary Care Hospital

Wazir Wahiba Mohammed ^{1*}, Afreen Saba ¹, Iffath Faria ¹, Rafia Amtul Muqet¹, Ur Rahman Mohammed Ateeq ²¹ PharmD PB Department of Pharmacy Practice, Mesco College of Pharmacy, Hyderabad, Telangana, India² HOD, Department of Pharmacy Practice, Mesco College of Pharmacy, Hyderabad, Telangana, India

ABSTRACT

Background: Elder people are a diversified group commonly presenting with multiple comorbid illnesses resulting into multiple prescriptions which in turn increases adverse effects and polypharmacy. Potentially inappropriate medications (PIM) further contribute to this risk. Therefore, the aim of this study was to assess the prescription appropriateness and (PIM) in geriatrics as per WHO core prescribing indicators and Beer's Criteria, 2015 respectively.

Methods: A prospective observational study was conducted in Osmania General Hospital, a Tertiary Care Teaching Hospital from December 2018 to May 2019. A total of 100 case records of inpatients greater than or equal to 60 years of age, in general medicine wards were reviewed. Relevant information was recorded in a structured proforma and data was evaluated.

Results: Out of 100 patients, 70 patients were male and 30 patients were female. Majority of them were from the age group of 65-70 years. There were 34% patients prescribed at least one PIM. Polypharmacy was observed in all patients. Average no. of drugs per prescription was 10.5%. Percentage of drugs prescribed from EDL (Essential drug list) were 84%. The p value of WHO core prescribing indicators was assessed using chi square test and was found to be significant.

Conclusion: Our study found WHO core prescribing indicators to be deviated from the optimum values set by WHO and high prevalence of Potentially Inappropriate Medications as per Beers criteria 2015. This highlights the need of future research work, strategies and regulatory measures focusing on geriatric patients and also encouraging prescribers to use the WHO core prescribing indicators and Beers criteria while prescribing elderly for providing optimum healthcare.

Keywords: Beer's criteria, Geriatrics, WHO prescribing indicators, Polypharmacy. Ageing, Potentially Inappropriate Medications.

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*Address for Correspondence:

Wahiba Mohammed Wazir, MESCO College of Pharmacy, Hyderabad, Telangana (500006), India

INTRODUCTION

Ageing can be described as a progressive functional decline or a gradual deterioration of physiological function with age.¹ The national policy on older persons adopted by government of India in 1999 defines senior citizen or elderly as a person who is 60 years or above.² The royal college of physicians (London) describes geriatric medicine as that branch of general medicine concerned with the clinical, preventive, remedial and social aspects of illness in older people.³

The elderly are prone to various problems like musculoskeletal stiffness, poor nutrition, sexual dysfunction etc. The presentations of diseases are also particular to older population. These presentations of diseases have been described as the "giants of geriatrics".⁴ The modern geriatric giants in elderly people are: "Instability, incontinence, intellectual impairment, incoherence (delirium), insulin resistance, immobility, inanition (malnutrition), and impoverishment". India has around 100 million elderly populations and is expected to further increase to 323 million, constituting 20% of total population by 2050.⁵

Polypharmacy, defined by the World Health Organization as "the administration of many drugs at the same time or the administration of an excessive number of drugs" is more common among the elderly as they mostly suffer from chronic diseases with concomitant pathologies. Inappropriate drug combinations, unnecessary medications, and inappropriate drugs for specific patients constitute the problems of polypharmacy.⁹

As older adults population is growing, the prevalence of chronic comorbid health conditions secondary to the inevitable nature of ageing expected to increase. This, therefore, is potentially associated with an increase in the use of multiple drugs (polypharmacy) to well manage these comorbidities or to prevent associated complications.⁶

Polypharmacy among older adults is common and consequently older patients are at higher risk of potentially inappropriate medications (PIMs) use.⁷ PIMs are defined as "medications that should be avoided due to their risk which outweighs their benefit and when there are equally or more effective but lower risk alternatives are available".⁸ PIMs are considered one of the commonly encountered medication-related problems among the older population. The use of PIMs is commonly evaluated using different scales and criteria such as the Beers criteria, which are a set of explicit criteria to identify PIMs. It was first developed in 1991 and consequently updated with the latest update in 2015¹⁰. It is well known that PIMs use among older patients is associated with negative health consequences and can impact patients' quality of life. PIMs use increases the risk of hospitalization, drug-related problems and other adverse health outcomes by two to three folds^{11, 12}.

Rational drug use is defined as "Patients receive medications appropriate to their clinical needs, in doses that meet their own individual requirements, for an adequate period of time, and at the lowest cost to them and their community." (WHO, 1985). To improve rational drug use, the patient should receive medicines appropriate to the clinical indication, at optimum doses and sufficient time, as well as at the cost-effective and economical that the individual and the community can afford. The main aim of rational drug use is to encourage better quality of pharmaceutical care, to minimize the cost of drug therapy, to avoid preventable adverse drug reactions and drug interactions, to maximize therapeutic outcomes and to promote patient adherence.⁹

Till date there is a paucity of research work combining drug utilization pattern and potentially inappropriate prescribing in a special population such as elderly.

Objective: The aim of this study was to investigate the prevalence of potentially inappropriate medications prescribed for elderly patients in a tertiary care hospital, using recent updated Beers criteria 2015. In addition, this study has been investigated for the prescription appropriateness using WHO core prescribing indicators.

MATERIALS AND METHODS

The study was a prospective observational study conducted in 100 patients who were admitted in Department of General Medicine, Osmania General Hospital, Hyderabad, India. The duration of the study was six months.

Inclusion Criteria:

- Patients of either sex.
- Patients above 60 years of age.
- Patients willing to give their consent.

Exclusion Criteria:

- Patients who are admitted in departments other than General Medicine Department.
- Patients who are critically ill and receiving palliative care.

Relevant data was collected after obtaining patients consent on the approved Informed consent form from the patients.

The following data was collected on designed data collection form for the study by observing patients' case sheet and interviewing patient or patient representatives are Patient's demographic data, Prescription prescribed by the physician, Patients medications, medical and social history.

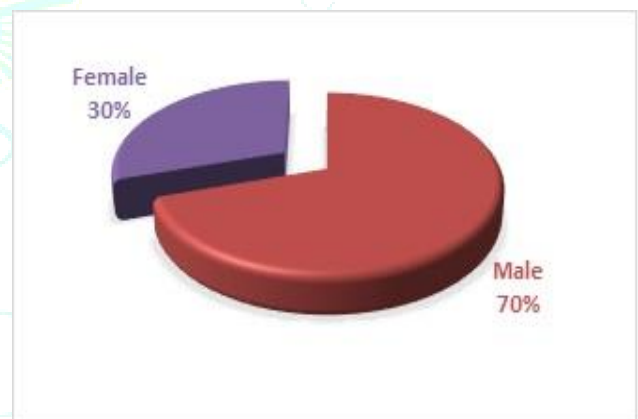
The data was assessed for prescription appropriateness using WHO core prescribing indicators and assessed the use of Potentially Inappropriate Medication (PIM) using Beer's criteria, 2015.

Statistical Analysis:

Data analysis was done based on the parameters assessed. The data was represented and the results were made by Graphical data representation using MS-Excel. Data was analyzed using Minitab version 19. The chi square goodness of-fit-test was used to compare the observed values and standard values of WHO core indicator.

RESULTS

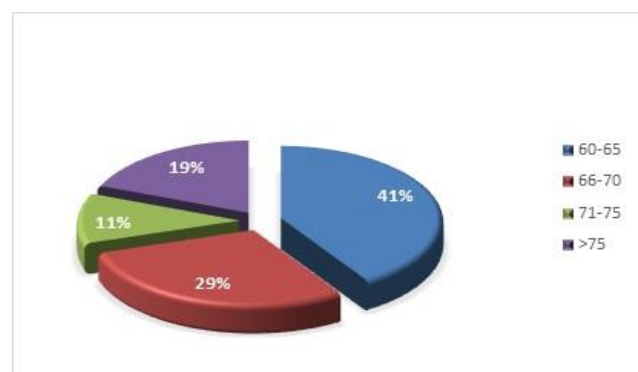
Gender Distribution:



Graph 1: Distribution of geriatrics based on gender

Result: The study populations were 100 of whom 70 patients were Male which accounts for 70% and 30 patients were Females which accounts for 30%.

Distribution of Geriatrics Based on Age – Group:



Graph 2: Distribution of geriatrics based on age group

Result: Graph 2 shows that the Age Groups of geriatrics that are hospitalized are more common from 60-65 Years of Age (41 patients) followed by 66-70 years of age (29 patients).

Distribution of Geriatrics Based on Localities:

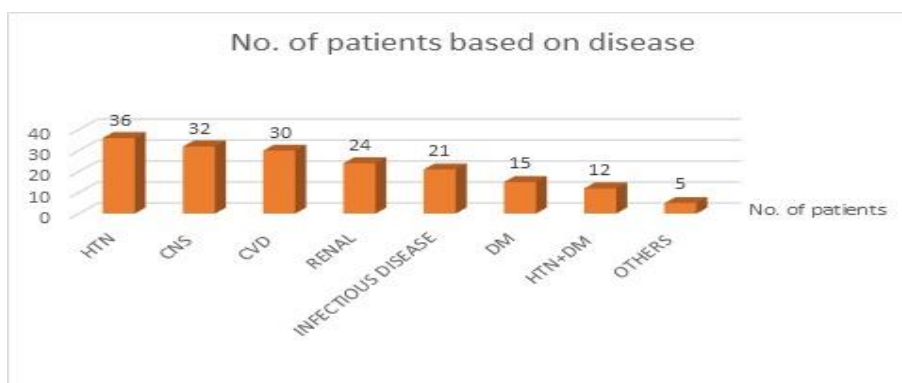
Table1: Distribution of geriatric based on localities.

Locals	Non locals
45	55

Distribution of Disease:

Table 2: Distribution of geriatrics based on disease

DISEASE	NO. OF PATIENTS
Hypertension	36
CNS disorders	32
Cardiovascular diseases	30
Renal disorders	24
Infectious diseases	21
Respiratory diseases	18
Diabetes	15
Hypertension+Diabetes mellitus	12
Others	05



Graph 3: Distribution of geriatrics based on disease

Class of Drugs:

Table 3: Distribution of drugs based on category

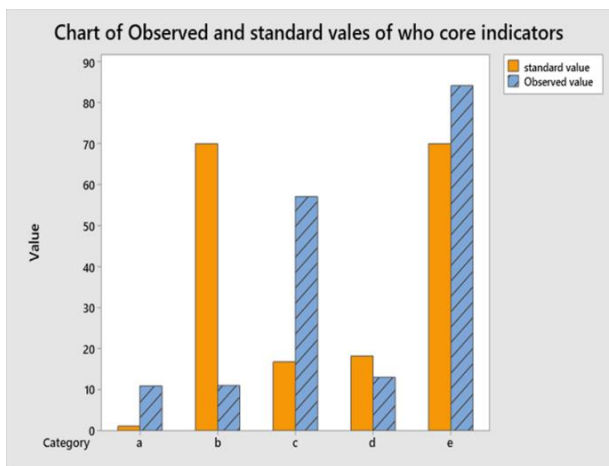
CATEGORY OF DRUGS	NO.OF DRUGS
DRUGS ACTING ON CVS (Atorvastatin, Amlodipine, Enalapril, Digoxin)	173
DRUGS ACTING ON GIT (Pantoprazole, Ondansetron, Ranitidine)	88
DRUGS ACTING ON HAEMATOLOGICAL SYSTEM (Iron Folic Acid)	04
ANALGESICS AND ANTI-INFLAMMATORY DRUGS (Diclofenac, Aspirin, Acetaminophen)	33
RESPIRATORY SYSTEM DRUGS (Deriphylline, Salbutamol, Hydrocortisone)	28
ENDOCRINAL SYSTEM DRUGS (Insulin, Metformin)	13
CNS DRUGS (Mannitol, Phenytoin, Lorazepam)	15
ANTI MICROBIALS (Metronidazole, Ceftriaxone, Piperacillin)	104
VITAMINS AND MINERALS (IV Fluids, Optineurin, B Complex)	91
ANTI HISTAMINE DRUGS (Chlorpheniramine)	20

Result: The most commonly prescribed drugs were those acting on CVS, followed by Anti-microbial and Vitamin supplements.

Who Core Indicators:

Table 4: Assessment of data using WHO Core Prescribing Indicators

CORE PRESCRIBING INDICATORS	OBSERVED VALUES	STANDARD VALUES
AVERAGE NUMBER OF DRUGS PER PRESCRIPTION	10.85	1.6-1.8
PERCENTAGE OF DRUGS PRESCRIBED IN GENERIC NAME	11%	100%
PERCENTAGE OF ENCOUNTERS WITH INJECTION PRESCRIBED	57%	13.4-24%
PERCENTAGE OF ENCOUNTERS WITH ANTIBIOTICS PRESCRIBED	13%	20-26%
PERCENTAGE OF DRUGS PRESCRIBED FROM ESSENTIAL DRUG LIST	84%	100%



a = Average number of drugs per prescription.
 b = Percentage of drugs prescribed in generic name.
 c = Percentage of encounters with injection prescribed.
 d = Percentage of encounters with antibiotics prescribed.
 e = Percentage of drugs prescribed from essential drug list.

Chi-Square Test:

N	DF	Chi-Sq	P-Value
175.85	4	235.097	0.000

The WHO core indicators were analyzed using chi square goodness of fit test and the p value was found to be 0 which indicates that there is a significant difference between expected values and observed values.

Potentially Inappropriate Medication:

Table 5: PIM found in the prescription

PIM	NO. OF PATIENTS	CONCERN	RECOMENDATION
Potentially inappropriate medication use in geriatrics to avoid:			
Digoxin	06	Decreased renal clearance of digoxin may lead to increases risk of toxic effects	Avoid doses >0.125mg/ day
Chlorpheniramine	15	Highly anti cholinergic; clearance reduced with advanced age	Avoid
Nifedipine	01	Potential for hypotension; risk of precipitating myocardial ischemia	Avoid
Clonidine	01	High risk of adverse CNS effects; may cause bradycardia and orthostatic hypotension	Avoid as first line anti-hypertensive
Alprazolam/ Lorazepam	01	Older adults have increased sensitivity to benzodiazepines and decreased metabolism of long acting agents	Avoid
Diclofenac	01	Increased risk of GI bleed or PUD in high risk groups such as aged >75.	Avoid chronic use

Non infective medications that should be avoided or have their dosages reduced with varying level of kidney function in older adults:

Cardiovascular/ hemostasis

Enoxaparin	01	Increased risk of bleeding when creatinine clearance is <30ml/min	Reduced dose
Spiroinolactone	03	Increase potassium Levels	If creatinine clearance is <30ml/min
Gastro intestinal			
Ranitidine	05	Causes mental status changes when creatinine clearance is <50ml/min	If use for GE reduce dose(150 mg/day)

No. of PIM prescribed during hospital stay

None	66
01	32
02	02

Drug-Drug Interactions:

Table 6: Drug-Drug interactions in prescribed drugs

DRUGS	INTERACTIONS	NO.OF PATIENTS
PIPERACILLIN+HEPARIN	Piperacillin increases effect of heparin by anti-coagulation.	01
CEFTRIAZONE+HEPARIN	Ceftriazone increases the effect of heparin by anti-coagulation.	02
DIGOXIN+METOPROLOL	Digoxin increases toxicity of metoprolol by unspecified interaction mechanism.	03
DIGOXIN+PANTOPRAZOLE	Pantoprazole increases effect of digoxin by increasing gastric pH.	02
CEFTRIAZONE+FUROSEMIDE	Ceftriazone increases toxicity of furosemide by pharmacodynamics synergism.	07

Polypharmacy:

Table 7: No. of drugs per prescription

No. of drugs per prescription	No. of patients
<5	02
5-10	56
>10	42

Result: Polypharmacy was found in all the patients.

Distribution of Geriatrics Based on Addictions:

Table 8: Social history of geriatrics

Addiction	No. of patients
Alcoholic	07
Ex-alcoholic	04
Smoker	08
Ex-smoker	06
Both	16
Others (tobacco etc)	02

Results: Incidence of geriatric's addiction is mainly found with both Alcohol and smoking.

(Most of the patients have no history of addiction (57%) then about 16% of patients are both Alcoholic and smoker.)

DISCUSSION

This work was done in Department of General Medicine, Osmania Hospital, over a period of six months. The principle aim of the study was to assess the prescription appropriateness and potentially inappropriate medications (PIM) in geriatrics as per Beer's Criteria, 2015.

In this study, out of 100 patients 70 patients were male and 30 patients were female. The predominance of male patients in this study is similar to other studies conducted in India.^{13,14,15} Majority of the patients belonged to the age group 60-65 years(41%), followed by age group 66-70 years(29%), followed by patients above 70 years of age, similar to finding of another study¹⁶. Most of the patients were non locals and had low socio-economic status.

The morbidity pattern in our study was commonly found to be cardiovascular conditions (36%) like hypertension, coronary artery disease and congestive cardiac failure. The second most common system affected was CNS conditions (32%) such as CVA. Third most common condition was renal disorders (24%). Whereas in another study conducted in India, morbidity pattern was cardiovascular diseases (29.33%), musculoskeletal conditions (27.67%) and endocrine disorders (13.34%)¹⁴. In our study, only 21 patients had infectious diseases and remaining were non-communicable diseases. This can be considered as an indicator to show an increasing trend of non-communicable diseases in India.

Most commonly prescribed drugs were cardiovascular drugs(30.4%), antibiotics(18.2%), vitamins and mineral supplements(15.4%) and anti-ulcer drugs(15.9%), whereas

Gopinath S et al showed in their study that Antibiotics were prescribed in 62.35%, antiulcer drugs (61%), anti-anxiety drugs (48%), Etophylline and theophylline combination (65%) was widely used in geriatrics population¹⁷.

Among the drugs, B complex vitamin was the most commonly prescribed drug. According to category wise distribution of drugs vitamins, minerals, and dietary supplements were the third most commonly prescribed drugs. Hence, this suggests elderly also suffer from nutritional deficiencies and in our study most patients complained of generalized body pains. There was increase in the use of drugs that decrease gastric acidity such as ranitidine and pantoprazole. This suggests more number of drugs per prescription led to increased prescription of these gastrointestinal drugs to avoid gastric irritation.

According to AGS Updated Beers Criteria 2015 for PIM use in elderly, our study shows almost 34% of elderly patient had encountered with at least one PIM. Although it is higher than similar study conducted in India¹³, but it is similar to other studies conducted in the USA (27.5%) and Iran (27.6%)^{34,35}.

PIMs prescribed from the group of drugs to be avoided included Antihistamines which were the most common PIMs prescribed, among which chlorpheniramine maleate was the most commonly prescribed PIM (15 patients) in our study. First generation of antihistamines are included in Beers criteria so other alternative drugs such as second and third generation antihistamines can be used in elderly patients. Beers criteria suggest that non COX selective NSAIDS must be avoided in high risk groups because these drugs increase gastrointestinal bleeding. Digoxin was prescribed to 4 patients in our study in more than the recommended dosage according to Beers criteria. These drugs must be used in dosage of <0.125 mg/day and less than 25 mg/day in elderly patients. Antipsychotics, tricyclic antidepressants and barbiturates must be avoided in elderly.

Clonidine was prescribed to a elderly patient in our study, it increases adverse CNS effects and hence its use as first line anti-hypertensive agent should be avoided.

Nifedipine was prescribed to a patient in our study, it has a potential for hypotension, risk of precipitating MI and hence should be avoided.

A patient in our study was prescribed Alprazolam, lorazepam. Older adults have increased sensitivity and decreased metabolism of long acting benzodiazepines, hence should be avoided.

Non infective medications that should be avoided or have their dosages reduced with varying level of kidney function in older adults include Ranitidine which was prescribed to five patients in our study. It causes mental status changes when creatinine clearance is <50ml/min. Hence dose should be reduced.

Enoxaparin was prescribed to a patient; it increases risk of bleeding when creatinine clearance is <30ml/min and hence the dose should be reduced.

Analysis of prescriptions using WHO drug use indicators showed that the average number of drugs per prescription was 10.85 which is less than a similar study on geriatric population conducted in India, where the average was 5.6²⁰. Prescription of five or more medications (polypharmacy) was observed in all patients in our study. In contrast, polypharmacy was observed only in 16.5% patients in a study conducted in Pondicherry¹⁴.

The percentage of drugs prescribed by generic name was 11%, which is very low compared to standard derived or

ideal (100%)¹⁹. Similar studies conducted at Karnataka¹⁸ showed it to be 70% whereas in a study on geriatric population conducted in Pondicherry¹⁴ found it to be 21.31%, which is higher than ours.

The percentage of encounters in which an injection was prescribed was 57%, which is much higher than the standard (13.4-24.1%) derived to be ideal¹⁹. Whereas, in a similar study conducted in India¹⁸, it was 26.33%, and is within acceptable limits.

The percentage of encounters in which antibiotics were prescribed was 13%, which is below the standard (20.0-26.8%) derived to be ideal¹⁸. In a similar study conducted in India¹⁴, it was found to be 23.5%, which is acceptable and higher than our findings.

The percentage of drugs prescribed from the Indian national essential drug list of India was 84%, which is close to the standard (100%) derived as ideal¹⁹. In similar studies conducted in India, it was less than ours (76.82%)¹⁴.

Drug-interactions found were among piperacillin-heparin, ceftriaxone-heparin, digoxin-metoprolol, digoxin-pantoprazole, fluoxetine-metoprolol.

The other drug related problems encountered in geriatrics in the present study were prescription of antibiotics without indication, prescription of Aspirin which should be avoided in patients >80 years as risk out-weighs benefits and Metformin which should not be used in patients >80 years unless normal renal function established and syrup cremaffin which is a laxative agent was prescribed in patient suffering from diarrhoea.

CONCLUSION

The study showed high prevalence of Potentially Inappropriate Medications (34%) as per Beer's criteria, 2015. Polypharmacy was seen in all the patients included in the study. The WHO core indicators were assessed using Chi-Square Goodness-of-Fit-Test and the p-value was found to be significant which indicates there is a statistical difference between observed values and expected values (standard values).

Reducing the rate of medication errors in geriatric patients is a challenging task due to comorbidities, multiple prescribers, polypharmacy, non-adherence, lack of sufficient efficacy and safety evidence of medications.

There is an enormous need of future research work, strategies and regulatory measures which should focus on specific evidence in older patients. Regular CMEs on use of Rational Drug Prescription and use of Beer's criteria among clinicians should be promoted while prescribing elderly. Availability of clinical pharmacology and clinical pharmacy practices for better healthcare outcomes needs to be increased.

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REFERENCES

1. Patridge L, Mangel M. Messages from mortality: the evolution of death rates in the old. *Trends Ecol Evol.* 1999; 14(1):438-42.
2. Geriatric knowledge today elderly population. Available at <http://www.gktoday.in/indias-elderlypopulation-some-fundamentals/>
3. British Geriatric Society-definition-geriatrics. Available at <http://www.bgs.org.uk/index.php/policydigest/228-about/administration/981geriatricsdefined>.
4. Madgaonkar CS. Family medicine. A clinical and applied orientation 2 nd Ed Jaypee medical publishers (p) lt.
5. Public relations bureau-reports-elderly population 2012. Available at <http://www.prb.org/publications/reports/2012/indiaolder-population.aspx>. d; 2015:247.
6. Jiron M, Pate V, Hanson LC, Lund JL, Jonsson Funk M, Strümer T. Trends in prevalence and determinants of potentially inappropriate prescribing in the United States: 2007 to 2012. *J Am Geriatric Soc.* 2016; 64(4):788-97.
7. Suehs BT, et al. Effect of potentially inappropriate use of antimuscarinic medications on healthcare use and cost in individuals with overactive bladder. *J Am Geriatr Soc.* 2016; 64(4):779-87
8. Page RL, II SA, Bryant LL, Ruscin JM. "Inappropriate prescribing in the hospitalized elderly patient: defining the problem, evaluation tools, and possible solutions". 2010; 75-87,
9. Sisay M, Mengistu G, Molla B, Amare F, Gabriel T. Evaluation of rational drug use based on World Health Organization core drug use indicators in selected public hospitals of eastern Ethiopia: a cross sectional study. *BMC Health Serv Res.* 2017; 17(1):161. Published 2017 Feb 23. Doi: 10.1186/s12913-017-2097-3
10. Panel, A.G.S.B.C.U.E, et al. American Geriatrics Society 2015 updated beers criteria for potentially inappropriate medication use in older adults. *J Am Geriatr Soc.* 2015; 63(11):2227-46.
11. Lu WH, Wen YW, Chen LK, Hsiao FY. Effect of polypharmacy, potentially inappropriate medications and anticholinergic burden on clinical outcomes: a retrospective cohort study. *CMAJ.* 2015; 187(4):E130-7.
12. Fick DM, Mion LC, Beers MH, L. Waller J. Health outcomes associated with potentially inappropriate medication use in older adults. *Res Nurs Health.* 2008; 31(1):42-51.
13. Zaveri HG, Mansuri SM, Patel VJ. Use of potentially inappropriate medicines in elderly: A prospective study in medicine out-patient department of a tertiary care teaching hospital. *Indian J Pharmacol* 2010; 42(2):95-8
14. Kanagasanthosh K, Topno I, Aravindkumar B. Prevalence of potentially inappropriate medication use and drug utilization pattern in elderly patients: A prospective study from a tertiary care hospital. *Int J Res Med Sci* 2015; 3(8):2062-72.
15. Shah RB, Gajjar BM, Desai SV. Drug utilization pattern among geriatric patients assessed with the anatomical therapeutic chemical classification defined daily dose system in a rural tertiary care teaching hospital. *Int J Nutr Pharmacol Neurol Dis* 2012; 2(3):258-65.
16. Prasad SN, Revankar S, Vedavathi H, Chidanand KN, Murray JL, Manjunath H. A study on prescription analysis and utilization of antibiotics in geriatric in-patients admitted in Shimoga institute of medical sciences tertiary care hospital, Shimoga, Karnataka, India. *Int J Basic Clin Pharmacol* 2016; 5:904-9.
17. Gopinath S, Rajalingam B, Sriram S, Subash V. An individual based study of the geriatric population: a polypharmacy. *International Journal of Pharmacy and Pharmaceutical Sciences.* 2011; 3(4):63-6
18. Nayaka SR, Rajeshwari B, Venkatadri TV. Drug utilization pattern in geriatric inpatients of medicine department in a Tertiary Care Teaching Hospital. *Int J Basic Clin Pharmacol* 2015; 3(4):568-73.
19. Isah AO, Ross-Degnan D, Quick J, Laing R, Mabadeje AF. The development of standard values for the WHO drug use prescribing indicators. ICUM/EDM/WHO. Available from: http://www.archives.who.int/prduc2004/rducd/ICIUM_Poster/1a2_txt.htm.
20. Prasanjit K Debnath* et al. A Study of drug utilization pattern of geriatric patients in the department of geriatric medicine in geriatric in a tertiary care hospital, Guwahati, Assam, India. *Asian J Pharm Clin Res*, 2010; 10(2):122-126
21. Supriya KH, Shashikumar NS, Prakash GM, Sareetha AV. A prospective observational study of prescription appropriateness of elderly hypertensive patients using Beers criteria in a tertiary care teaching hospital. *Int J Basic Clin Pharmacol* 2017; 6:2545-50
22. Austin RP. Poly-pharmacy a risk factor in the treatment of type 2 diabetes. *Diabetes Spectrum.* 2006; 19(1):13-6.
23. C. S. van der Hooft et al. Inappropriate drug prescribing in older adults: the updated 2002 Beers criteria – a population-based cohort study. *Br J Clin Pharmacol.*
24. D. Fialová & G. Onder. Medication errors in elderly people: contributing factors and future perspectives. *Br J Clin Pharmacol* DOI:10.1111/j.1365-2125.2009.03419.x
25. Prakash Goudanavar et al.: *Asian Journal of Biomedical and Pharmaceutical Sciences*, 2016; 6(56):23-27.
26. Anitha Nandagopal et al. Assessment of Rational Drug Prescribing Pattern in Geriatric Patients in Hyderabad Metropolitan Indian *Journal of Pharmacy Practice*, 2017; 10(3).
27. Neha Sharma et al. Screening of prescriptions in geriatric population in a tertiary care teaching hospital in north India *The Journal of Phytopharmacology* 2013; 2(5):38-45.
28. Bhavshaikh N et al. Drug prescribing patterns in elderly patients in a tertiary level hospital *Int J Basic Clin Pharmacol.* 2017 Apr; 6(4):759-764
29. Binaya Shrestha et al. Assessment of Drug Use Pattern Using WHO Prescribing Indicators *JNHRC* 2018; Vol. 16 No. 3 Issue 40
30. Eman Elayeh et al. Assessment of appropriate medication use by 2015 Beers criteria among elderly critically ill patients in Jordan *Clin. Pract.* 2018; 15(4):765-774
31. Sultan H, Sayegh K, Mohammad A, et al. Prescribing pattern of drugs in the geriatric patients in jazan province, KSA. *Pharm Pharmacol Int J.* 2015; 2(1):30-34. DOI: 10.15406/ppij.2015.02.00013
32. Edward K. Osei et al. Prevalence of Beers Criteria Medications Among Elderly Patients in a Military Hospital. *Gerontology & Geriatric Medicine* Volume 2: 1-6
33. Hsu WH, Hsiao PJ, Lin PC, Chen SC, Lee MY, Shin SJ. Effect of metformin on kidney function in patients with type 2 diabetes mellitus and moderate chronic kidney disease. *Oncotarget.* 2017; 9(4):5416-5423. Published 2017 Dec 17. doi:10.18632/oncotarget.23387
34. Gavián Moral E, Morales Suárez-Varela MT, Hoyos Esteban JA, Pérez Suanes AM. Inappropriate multiple medication and prescribing of drugs immobile elderly patients living in the community. *Aten Primaria.* 2006; 38(9):476-480
35. Steinman MA, Landefeld CS, Rosenthal GE, Berthenthal D, Sen S, Kaboli PJ. Polypharmacy and prescribing quality in older people. *J Am Geriatr Soc.* 2006; 54(10):1516-1523