



Analysis of Beer's Criteria 2019 and Patient Characteristics of Potentially Inappropriate Medication in Elderly Patients with Diabetes Mellitus

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ABSTRACT

Background: Elderly patients with type 2 diabetes mellitus with polypharmacy and various comorbidities often have problems with Potentially Inappropriate Medications (PIMs). One of the methods commonly used to detect this event is Beer's Criteria 2019.

Objectives: This study aims to: (1) identify the characteristics of elderly hospitalized patients with type 2 DM; (2) analyze the incidence of PIM in patients; and (3) analyze the relationship between characteristics (age, gender, comorbidities, length of stay, and number of drugs given) with the incidence of PIMs.

Methods: The research was conducted at two type C hospitals in the city of Bengkulu, with a total of 105 patients using the purposive sampling method. This research is a cross-sectional study with data collection techniques in the form of medical record data from patients for the period January – December 2022 who received drug therapy. Data analysis consists of comparing data with Beer's Criteria, quantitative descriptive and Fisher's test.

Results: The research results showed that: (1) the largest age group in Hospitals) had comorbidities, the highest number of drugs given was more than 10 types of drugs, and the majority of patients were hospitalized for less than five days; (2) There was an incidence of PIMs of 98.65% (73 patients) in Hospital (3) Statistical tests show that there is no relationship between age, gender, comorbidities, number of medications and length of stay with the incidence of PIMs.

Conclusion: There is still inappropriate use of drugs given to elderly DM patients. It is hoped that further researchers will be able to find out the reasons for giving these drugs to elderly patients.

Keywords: Beer's Criteria 2019; DM Type 2; elderly; PIM; Polypharmacy

INTRODUCTION

Based on data from the World Health Organization (WHO), the population of elderly people is estimated to reach 2.1 billion in 2050¹; where in almost five decades, the number of elderly people in Indonesia has increasingly doubled (1971-2020), namely 9.92% or as many as 26 million people. The population in Bengkulu province is 2 million people; the percentage of older adults is dominated by the 60-69 year age group at 5.60%, older adults in the 70-79 year age group are 1.91%, and elderly people in the age group over 80 years are 0.55%².

Elderly or geriatric patients are people who have more than one disease, so they are often vulnerable to inappropriate medication administration, which can lead to the risk of side effects from the medication³. One thing that must be considered is the inappropriateness of administering medication to geriatric patients with chronic diseases, such as diabetes mellitus. Diabetes mellitus is a metabolic disease that is often found in elderly patients. This disease is a chronic disease caused by the pancreas not being able to produce enough insulin⁴. Elderly diabetes sufferers, who are often accompanied by other comorbidities, certainly pose a challenge for health workers regarding disease management patterns at this age due to varied pathological conditions,

polypharmacy, decreased organ function, and atypical disease manifestations. This certainly encourages Potentially Inappropriate Medication (PIM) or potentially inappropriate medication. 5

PIM is an important clinical problem because patients with polypharmacy are less likely to benefit from treatment compared with patients who receive fewer medications. With metabolic conditions that cannot work optimally and several comorbidities that elderly people have, this results in them consuming a lot of medication during treatment. In general, inpatients receive a greater number of drug prescriptions while in Hospital, thereby increasing the risk of drug side effects. Therefore, avoiding drugs that are considered inappropriate is one of the interventions for treatment options in elderly patients 6.

Beer's Criteria is one of the most frequently used methods to identify PIM use in the elderly 7. Beer's Criteria aims to reduce drug-related problems in older adults consisting of potentially inappropriate drug exposure, drug-drug interactions, drug-disease interactions, and drugs that should be used with caution in older adults age 7. Comorbidities of diabetes were selected because they are the most common group of diseases and impose a higher burden on patients, payers, and the health care system. Beer's Criteria is a tool that can be used to evaluate potential incidents of inappropriate drug use in geriatrics. Since 2012, Beer's Criteria have been updated every three years. Beer's Criteria 2019 is an update of Beer's Criteria 2015, so this research will be one of the latest studies using Beer's Criteria 2019 to analyze PIM.

I have studied several times. Previous research reported that the incidence of Potentially Inappropriate Medication (PIM) was found to be 62.5% in geriatric patients, where female gender and polypharmacy were risk factors for PIM 8. Other studies also reported that the prevalence of patients who received PIM was 23.5% based on the 2012 Beer's Criteria 9 and around 55.6% of identified patients (PIM) based on the 2015 Beer's Criteria 10. Previous research in 2020 reported that PIM was found in geriatric patients with type 2 diabetes mellitus during hospitalization, polypharmacy, decreased kidney function, and female gender are associated with a higher incidence of PIM 10.

Other research shows a significant relationship between the incidence of PIM, the number of medications four, and the patient's length of stay 11. Meanwhile, the relationship with age, gender, and comorbidities was previously studied in 2018; although the results did not show a relationship, these characteristics can still be studied further 12. The use of drugs in elderly patients requires consideration to avoid potentially inappropriate use of type 2 DM drugs. Avoiding prescribing potentially inappropriate medications (PIMs) to patients can improve health care. Therefore, this study aims to identify the prevalence of PIM in elderly patients with Type 2 DM hospitalized at a Hospital for long hospitalization. It is hoped that the research results can be used as a reference in evaluating hospital services so that the safety of using type 2 DM drugs will increase and reduce the risk of morbidity and mortality in elderly patients in the city of Bengkulu.

METHODS

Research design

This research is a cross-sectional and prospective study during the period January 2022 – December 2022 at two type C hospitals in the city of Bengkulu, which will hereinafter be referred to as Hospital X and Hospital Y. The PIM identification process was carried out by comparing treatment records with the 2019 Beer's Criteria list. Meanwhile, the relationship between PIM incidence and characteristics will be tested statistically.

Population and Sample

The sample in this study was selected using a purposive sampling method with inclusion criteria: (a) type 2 DM patients who underwent examinations in the period January 2022 – December 2022 at 2 predetermined hospitals; (b) Elderly patients aged >60 years; (c) type 2 DM patients without comorbidities or with comorbidities; (d) complete patient medical record data including age, gender, diagnosis, drug name, dosage form, dose, route of use, total use and frequency of use. Apart from that, there are also exclusion criteria, namely: (a) the patient's medical record data is incomplete; (b) the patient was forced to return home/died/was referred to another location. Based on the criteria above, a total of 105 patients were obtained who met the inclusion criteria, with details of 74 patients at Hospital X and 31 patients at Hospital Y.

Data collection

The data collected is data from type 2 DM patients who underwent treatment in June 2022 - December 2022 at Hospital X and Hospital Y, Bengkulu City. Data was collected manually by filtering data that matched the research sample criteria and transferring it to a data collection sheet which included medical record number,

age, gender, comorbidities, number of drugs given and length of stay. The data source comes from patient medical records obtained from data reports in the medical records unit and hospital laboratory unit.

Data analysis

Data were analyzed using: (1) quantitative descriptive analysis comparing characteristics between Hospitals X and Y; (2) univariate analysis used to determine the incidence of PIM in elderly patients who were identified using the 2019 Beer's criteria by looking at the patient's medical record data for their treatment, then recording the treatment data of all patients who met the inclusion criteria one by one, then comparing them using the Beer's method. 2019 criteria to find out which drugs fall into the PIM category. In the 2019 Beer's Criteria analysis, these criteria are divided into 5 categories, namely category 1 "drugs that should be avoided in general in elderly patients", category 2 "drugs that should be avoided if suffering from history of certain diseases", category 3 "drugs that can still be given to the elderly but with special attention or caution", category 4 "interactions between drugs that have the potential to be clinically important because they can worsen the condition of the elderly if given which must be avoided", and category 5 "drugs that should be avoided or reduced in dose with varying levels of kidney function in the elderly". and (3) bivariate analysis to determine the relationship between demographic data and the incidence of PIM in hospitals using Fisher's statistical test.

RESULTS AND DISCUSSION

Characteristics of Type 2 Elderly Patients

Based on table I, information is obtained that the elderly age group that has been categorized according to the Ministry of Health, is mostly in the 60-69 year old, both at Hospital X and Hospital Y with each receiving 55 patients (74.32%) at Hospital X and 25 patients (80.64%) at Hospital Y. This data shows that the higher the age group, the fewer the number of patients hospitalized. The 60-69 year old group is the age most vulnerable to diabetes, because at this age, especially 65 years and above, a person's risk of developing diabetes will also increase. This is caused by glucose intolerance and a decrease in the function of the pancreas in producing insulin.¹³

Based on gender differences, women are generally more susceptible to diabetes than men.⁸ However, the research results show that in terms of percentage and number, the number of women and men is almost the same. At Hospital X, the number of elderly male patients with type 2 DM was slightly higher than female patients (51.61% > 48.39%). This proves that diabetes is often accompanied by other chronic diseases such as hypertension, high cholesterol, cardiovascular disease, insomnia and anxiety.¹⁴

The number of drug administrations of more than 10 types of drugs also still occurred at Hospital X as much as 48.64% and Hospital Y as much as 70.93%. In the medical record data that researchers obtained, although the level of drug administration was less than 10 types, it was still quite a large amount, such as 8-9 types of drugs given. This is polypharmacy and is something that is dangerous for elderly patients with Type 2 DM. However, according to previous research, the causes of polypharmacy in these elderly patients are the chronic multipathological disease they suffer from, drugs prescribed by more than one doctor, the symptoms felt by the patient are often unclear, the patient often asking for prescription drugs, and administering new drugs to eliminate the side effects of drugs that have been consumed previously.¹⁵ Meanwhile, regarding the length of stay variable for elderly patients with type 2 DM in both hospitals, it was recorded that more patients were hospitalized for less than five days, recorded at Hospital X at 92.86% and at Hospital Y at 77.42%. This indicates that many patients were sent home when the symptoms had improved and treatment continued on an outpatient basis.

Analysis of Potentially Inappropriate Medications (PIMs)

Assessment PIMs in this research use Beer's Criteria 2019, which is one of the method for measure nonconformity treatment that includes the best medicines avoided or can be used with attention especially for patients elderly 60 years old and above.¹⁶ Assessment done with method view recorded data medical Type 2 DM patients at Hospitals X and Y, then seen treatment existing patients given during take care stay. Medications are recorded and compared with the 2019 Beer's criteria method and observed to find out what medications are inappropriately given to patients.

From the two hospitals in Bengkulu City which were the research conducted, the incidence of PIMs in Hospital X was 98.65% (n=73) and Hospital Y was 96.77% (n=30). This indicates that many PIM incidents occurred in these two hospitals.

According to the 2019 Beer's Criteria, there were 15 patients in Hospital X and 15 patients in Hospital Y who received at least one PIMs who were hospitalized with Type 2 DM. In this study, the use of diabetes drugs

Table I. Description of characteristics of elderly Type 2 DM patients treated at Hospitals X and Y for the period January 2022 - December 2022

Characteristics	N=74		N=31	
	Hospital X		Hospital Y	
	n	%	n	%
Age				
60-69 years old	55	74.32%	25	80.64%
70-79 years old	15	20.27%	5	16.13%
>80 years	4	5.41%	1	3.23%
Gender				
Man	33	44.59%	16	51.61%
Woman	41	55.41%	15	48.39%
Concomitant Diseases				
There is	65	87.84%	25	80.65%
There isn't any	9	12.16%	6	19.35%
Number of Drugs				
< 10 types	38	51.35%	9	29.03%
≥ 10 types	36	48.65%	22	70.93%
Length of Hospitalization				
<5 days	60	81.08%	24	77.42%
≥5 days	14	18.92%	7	22.58%

Table II. Prevalence of Concomitant Disease Conditions in Elderly Patients with Type 2 DM

Diagnosis	n (%)	
	Hospital X	Hospital Y
DM Type 2	29.73	51.60
Type 2 DM Type 2, Hypertension	25.68	16.30
Type 2 DM, Kidney Disease	17.57	-
Type 2 DM, Congestive Heart Failure (CHF)	1.35	6.44
Type 2 DM, Anemia	4.05	3.23
Type 2 DM, Respiratory Disease	8,11	6.44
DM Type 2, UTI	4.05	3.23
DM Type 2, OA	1.35	-
Type 2 DM, Coronary Heart Disease (CAD)	-	6.44
Type 2 DM, UAP, CAD & Hypertension	1.35	3.23
Type 2 DM, Hypertension, Anemia	-	3.23
Type 2 DM, CKD & Hypertension	2.70	-
Type 2 DM, CKD & Anemia	1.35	-
Type 2 DM, Hypertension & UTI	2.70	-
Total	74	31

included in the Beer's Criteria was still quite high. The insulin sliding scale group is seen in the administration of insulin to Type 2 DM patients, when only one is given (basal/ long acting), then the occurrence of PIM is calculated. Table IV is obtained from the results of examining medical record data which has been compared with the Beer's criteria method to determine the incidence of PIM in Type 2 DM patients at Hospitals .67% at Hospital Y. Apart from clear guidelines, the use of a sliding insulin scale is also common. Insulin therapy in the elderly with poor glycemic control, HbA1c levels > 9% (74.9 mmol/mol), FPG levels > 250 mg/dL (13.9 mmol/L), random glucose values > 300 mg/dL or patients with ketonuria, insulin should be administered and is chosen as initial therapy. When initiating insulin therapy in elderly patients, it is important to have general health status, ability to make insulin, measure blood sugar, understanding of hypoglycemia, and capacity to treat it. ¹⁷

Among antidiabetic drugs, the most frequently prescribed PIMs are sliding scale insulin, glimepiride and glibenclamide, because these drugs can cause severe prolonged hypoglycemia in the elderly, whereas sliding

Table III. PIM incident at Hospital X and Hospital Y, Bengkulu City

PIMs	N=74		N=31	
	RS		Y Hospital	
	n	%	n	%
PIMs occurrence				
There is	73	98.65%	30	96.77%
There isn't any	1	1.35%	1	3.23%

Table IV. Type 2 DM medication prescribed for hospitalized elderly Type 2 DM patients

Drug Class	RS		Y Hospital	
	n	%	n	%
Insulin, <i>sliding scale</i> (Insulin regimen containing only short-acting or rapid-acting insulin dosed according to current blood glucose levels without concomitant use of basal or long-acting insulin).	8	53.33	4	26.67
Sulfonylureas				
Glimepiride	5	33.33	11	73.33
Glibenclamide	2	13.33	-	-
Total	15	100	15	100

scale insulin (short or rapid acting) is an approved agent for these patients. Diabetes.¹⁹ However, older patients may be at higher risk of hypoglycemia without improving hyperglycemia management.¹⁵ Use of insulin based on random blood glucose should be avoided (insulin regimens containing only short-acting or rapid-acting insulin dosed according to current blood glucose levels without concomitant use of basal or long-acting insulin). The findings of this study are in line with a 2020 study which stated that 19.7% of PIMs were related to sliding scale insulin based on the 2015 and 2019 Beer's Criteria.¹⁰

The overall incidence of PIMs based on Beer's Criteria 2019 in this study was 98.65% (73/74) in Hospital X and 96.77% (30/31) in Hospital Y. Inpatient elderly patients also receive treatment apart from providing therapy for Type 2 DM due to congenital diseases suffered by the elderly patient himself. So a large number of drugs can be given because the patient may have one or more comorbidities. In the analysis Beer's Criteria 2019, these criteria are divided into 5 categories, namely category 1 "drugs that should be avoided in general in elderly patients", category 2 "drugs that should be avoided if you suffer from a history of certain diseases", category 3 "drugs that can still be given to the elderly but with special attention or caution", category 4 "interactions of drugs that are potentially clinically important because they can worsen the condition of the elderly if given and should be avoided", and category 5 "drugs that should be avoided or reduced in dose by various levels of kidney function in the elderly". Obtaining drugs given based on categories included in the Beer's Criteria at Hospitals X and Y can be seen in table V.

The incidence of drug incompatibility (PIM) in this study, when viewed from categories 1 to 5, shows that category 1 is the category that occurs most frequently. Meanwhile, the most widely used drug is omeprazole. The reason the possibility of using omeprazole is greater than ranitidine which has the same function is Ranitidine has been proven to be safer to administer compared to omeprazole. This is likely because when elderly patients develop gastric ulcers, they are more likely to heal when the patient receives concurrent treatment with a PPI rather than ranitidine.²⁰

The use of furosemide in this study was also quite high, especially at Hospital However, The American College of Cardiology/American Heart Association (ACC/AHA) does not recommend use loop diuretic as drug line First For treating hypertension²¹. So on research At this point, furosemide was given as treatment line second in patients, although furosemide was included in Beer's Criteria category 3 which is treatment given must in a way be careful.

Based on the results obtained, the use of PIMs in patients elderly with Type 2 DM care stay in study This different One each other, on some patient only use one PIMs, whereas a number of patient other use more from one PIMs. The number of PIMs used per patient can be seen in table VI below.

Table V. Medicines categorized into the 2019 Beer's Criteria given to elderly patients with Type 2 DM with comorbidities

Medicine name	RS		Y Hospital	
	n	%	n	%
Category 1				
Omeprazole	59	39.86	21	30
Lansoprazole	10	6.76	8	11.43
Ketorolac	7	4.73	7	10
Clonidine	1	0.68	-	-
Na. Diclofenac	2	1.35	1	1.43
Nifedipine	1	0.68	1	1.43
Meloxicam	-	-	2	2.86
Metoclopramide	1	0.68	1	1.43
Diazepam	-	-	2	2.86
Alprazolam	10	6.76	2	2.86
Digoxin	-	-	1	1.43
Category 2				
Mefenamic acid	7	4.73	1	1.43
Cilostazol	-	-	2	2.86
Category 3				
Furosemide	20	13.51	4	5.71
Aspirin	4	2.70	2	2.86
Spirolactone	1	0.68	-	-
Diphenhydramine	1	0.68	1	1.43
Haloperidol	-	-	-	-
Category 4				
Corticosteroids + Oral or Parenteral NSAIDs	6	4.05	1	1.43
Category 5				
Ranitidine	4	2.70	3	4.29
Tramadol	-	-	1	1.43
Gabapentin	5	3.38	8	11.43
Ciprofloxacin	9	6.08	1	1.43
Total	148	100	70	100

Table VI. Use of PIMs in hospitalized elderly patients with Type 2 DM

Use of PIMs per patient	Number of Patients	Percentage (%)	Y Hospital	
			Number of Patients	Percentage (%)
0	1	1.35	1	3.26
1	18	24.32	8	25.81
2	28	37.84	6	19.34
3	15	20.27	3	9.68
4	10	13.51	8	25.81
5	2	2.70	5	16.13

The number of PIMs that occur in elderly patients with Type 2 DM ranges from 1-5. This indicates that medications listed in the 2019 Beer's Criteria should be administered with caution, if not avoided, because the risk of side effects outweighs the benefits when used in elderly patients.²⁰

Association Between Patient Characteristics and PIMs

The results of statistical tests showed that patient characteristics or risk factors studied did not have a significant relationship with the incidence of PIMs in Hospital X and Hospital Y in Bengkulu City (p>0.05). This is in line with previous research which states that factors such as age, gender,⁵ comorbidities,²² number of drugs

Table VII. Results Analysis of the characteristics of risk factors that influence the use of PIMs in the entire study sample

Variable	PIMs		p
	N	%	
Age			
60-69 years old	80	76.19%	0.430
70-79 years old	20	19.04%	
≥80 years old	5	4.76%	
Gender			
Man	49	46.66%	0.497
Woman	56	53.33%	
Concomitant Diseases			
There is	90	85.71 %	0.266
There isn't any	15	14.28 %	
Number of Drugs (type)			
< 10	47	44.76%	0.198
≥ 10	58	55.23%	
Length of Hospitalization			
<5 days	84	80.00%	1,000
≥5 days	21	20.00%	

Table VIII. Table Example (Without vertical lines)

Characteristic	N (%)
Gender	
Male	6 (15.4)
Female	33 (84.6)

given and length of stay¹² are not related to the incidence of PIMs. Thus, it is possible that the occurrence of PIMs in the two Bengkulu City hospitals is influenced by other factors not examined in this study.

Results should be clear and concise. Show only the most significant or main findings of the research. Describe the outcome of the study. Describe Tables as "Table" and Figures as "Figure" (not "Fig."). Every figure should have a title or caption, which should be concise but clear enough to explain its main components independently from the text.

Each data presented is discussed comprehensively in one flow: presenting the data, comparing it with other similar research, and putting forward relevant theories related to the existing data.

Discussion must explore the significance of the results of the study. Adequate discussion or comparison of the current results to the previous similar published articles should be provided to show the positioning of the present research (if available).

CONCLUSION

Based on the research results obtained, there was an incidence of PIMs in elderly patients with type 2 DM who were hospitalized, amounting to 73 patients (98.65%) in Hospital aged 60-69 years . Meanwhile, the antidiabetic drug classes included in the 2019 *Beer's criteria category are sliding scale insulin* , glimepride, and glibenclamide. Of the several risk factors or patient characteristics studied, there was no relationship between age, gender, length of stay, number of medications and comorbidities on the incidence of PIMs ($p > 0.05$).

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STATEMENT OF ETHICS

Ethical Clearance was submitted to the Medical/Health Research Bioethics Commission, Faculty of Medicine, Sultan Agung Islamic University, Semarang, and a recommendation for implementation at Bengkulu City Hospital was issued in March 2023 with number 127/III/2023/Bioethics Commission.

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