



Detection of Potentially Inappropriate Medication in Elderly Outpatient Based on The Beer's Criteria 2019

Nurmainah*, Rindu Astuti, Ressi Susanti

Pharmacy Study Program, Faculty of Medicine, Tanjungpura University, Pontianak, Indonesia

*Corresponding author: nurmainah@pharm.untan.ac.id

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Abstract

Background: Elderly patients generally have more than one disease, so they need several drugs to treat the condition and Potentially Inappropriate Medication (PIM). **Objective:** This study aimed to examine the inaccuracy of prescription drugs in the elderly using Beer's criteria 2019. **Methods:** The research method used an observational study with a descriptive cross-sectional design. Beer's Criteria 2019 was compiled by The American Geriatrics Society (AGS) and grouped PIM into five categories. A total of 138 prescriptions met the inclusion criteria at the Internal Medicine Clinic. **Results:** The results showed that the elderly who received the prescription was in the age range of 60-69 years (73.2%), male gender (54%), and had comorbidity (77.5%). Of the 138 prescriptions for elderly patients, 117 prescriptions for elderly patients experienced PIM incidence (84.78%). The percentage of PIM incidents was based on categories; namely, category 1 was 74.2%, category 2 was 3.5%, 3 was 16.7%, category 4 was 3%, and category 5 was 2.5%. Medicines that include PIM in category 1 are lansoprazole, glimepiride, glibenclamide, alprazolam, diazepam, amitriptyline, diclofenac sodium, ibuprofen, meloxicam. PIM in category 2 are cilostazol, pioglitazone, and diclofenac sodium. Category 3 PIMs include furosemide, spironolactone, and hydrochlorothiazide (HCT), category 4 PIMs include dexamethasone-sodium diclofenac, methylprednisolone-ibuprofen, and alprazolam-codeine, and category 5 PIMs include spironolactone, ciprofloxacin, and ranitidine. **Conclusion:** This study concludes that the elderly are at risk for receiving inappropriate drug prescriptions. Patients received more drugs belonging to category 1 PIM than category 2, 3, 4, and 5.

Keywords: elderly, beer's criteria 2019, PIM

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INTRODUCTION

The elderly are susceptible to various physical complaints due to natural factors and disease factors (Kementerian Kesehatan Republik Indonesia, 2014). The aging process occurs due to changes in various organs, including the gastrointestinal system, genitourinary system, central nervous system, and others (Astuti *et al.*, 2017). As a result, the morbidity rate in the elderly in Indonesia is relatively high in which there are 27 out of 100 elderly who experience pain (Badan Pusat Statistik, 2018). Degenerative diseases dominate the main disease pattern in the elderly. This health problem requires the elderly to take medication (Rahmawati *et al.*, 2019; Tamher, 2009).

Drug selection for the elderly group is a complex process. Thus, the elderly are vulnerable to potentially inappropriate medication (PIM). Besides, generally, the elderly have comorbidities and experience changes in physiological conditions that can affect pharmacokinetics and pharmacodynamic sensitivity to certain drugs (Abdulah & Barliana, 2015). Therefore, the selection of medications for elderly patients should be made carefully by considering the benefits and risks involved (Walsh, 1997).

Beer's Criteria is one of the explicit criteria that can improve the selection of drugs for the elderly, reduce the incidence of adverse drugs, and function as a tool to evaluate the quality of care, costs, and patterns of drug use in the elderly (American Geriatrics Society, 2019). Based on some research results, it was found that the use of unrecommended drugs in the elderly such as non-steroidal anti-inflammatory drugs (NSAIDs), proton pump inhibitors (PPI), digoxin, antihistamine two blockers, and psychotropics (Mulyani & Rukminingsih, 2020; Negara *et al.*, 2016). The use of this drug is risky for the condition of elderly patients. For example, NSAIDs are very risky in elderly patients with heart problems as this drug can inhibit prostaglandins and worsen heart failure conditions. Besides, NSAIDs are risky for gastrointestinal bleeding or peptic ulcers (Mulyani & Rukminingsih, 2020). Furthermore, psychotropic drugs can cause prolonged sedation and an increased risk of falls and fractures (Setyowati *et al.*, 2011).

The detection using the Beer's Criteria method found the pattern of potentially inappropriate medication in every hospital. For example, at the Semarang City hospital, the prescription of NSAID PIM class reached 25.05% (Mulyani & Rukminingsih, 2020). Besides, Purwokerto City Hospital tended to prescribe diazepam at 31.0% (Setyowati *et al.*, 2011). Based on

these data, there are differences in PIM patterns in each hospital. Therefore, the researcher is interested in describing the percentage of PIM incidence in Sultan Syarif Mohamad Alkadrie Hospital, Pontianak City. Research on PIM prescription incidents for elderly patients at this hospital has never been carried out using the Beer's Criteria 2019 method so far.

Beer's Criteria 2019 includes five categories for determining the prevalence of PIM in elderly patients. Drugs in category one should be avoided in elderly patients; drugs in category two should be avoided if a patient has a history of certain diseases; drugs in category three can still be used with caution; drugs in category four cause drug-disease interactions; and drugs in category five should be reduced in dose or avoided if a patient has a history of certain diseases (American Geriatrics Society, 2019).

MATERIALS AND METHODS

This observational study used a descriptive cross-sectional design. Data were collected retrospectively using an electronic prescription and medical record database for elderly patients at Sultan Syarif Mohamad Alkadrie Hospital, Pontianak, from January-June 2020.

The study was conducted on outpatient elderly at the Internal Medicine Clinic with inclusion criteria of 1) age > 60 years, 2) having laboratory data for serum creatinine, and 3) at least taking one drug. The exclusion criteria were the patient's identity which was not recorded in the prescription and medical record data. The variables of this study were the type of drugs, medical history, and laboratory data.

Drug use and laboratory data obtained for the elderly were identified as potentially inappropriate medication (PIM) using Beer's Criteria 2019. Beer's Criteria 2019 was compiled by The American Geriatrics Society (AGS). These guidelines aim to improve drug selection, educate clinicians and patients, reduce adverse drug events, and serve as a tool for evaluating older adults' quality of care, cost, and drug use patterns. Beer's criteria include five types of drugs, which are as follows:

Category 1) potentially inappropriate medication use in older adults. Example: anticholinergic, antiparkinsonian agents, benztropine (oral), trihexyphenidyl, antithrombotics, anti-infective, etc.

Category 2) potentially inappropriate medication use in older adults due to drug-disease or drug-syndrome interactions exacerbate the disease or syndrome. Example: Drugs that act on the cardiovascular system, syncope, delirium, a history of falls or fractures,

gastrointestinal, kidney, or urinary tract problems, and urinary incontinence (all types) in women are examples. Category 3) potentially inappropriate medications: drugs to be used with caution in older adults. Example: aspirin for primary prevention of cardiovascular disease and colorectal cancer, dabigatran, rivaroxaban, prasugrel, antipsychotics, carbamazepine, diuretics, mirtazapine, oxcarbazepine, SNRIs, SSRIs, TCAs, Tramadol, dextromethorphan/quinidine, trimethoprim-sulfamethoxazole.

Category 4) potentially clinically critical drug-drug interactions should be avoided in older adults. Example: RAS inhibitor-RAS inhibitor, opioids-benzodiazepines, anticholinergic-anticholinergic, corticosteroid-NSAID, etc.

Category 5) medications that should be avoided or have their dosage reduced with varying levels of kidney function in older adults. Example: anti-infective (ciprofloxacin, trimethoprim-sulfamethoxazole), cardiovascular and hemostasis (amiloride, dabigatran, edoxaban, spironolactone), SSP drugs and analgesics, gastrointestinal.

PIM was identified in samples containing one or more drugs from Beer's Criteria 2019 drug list. Based on the criteria of each, the sample in the PIM category is divided into five categories of Beer's Criteria 2019. The categorizing of PIM from data on drug use in the elderly was done by the research team without the involvement of clinicians in this study. The investigation also included secondary data from prescription and medical records of older patients. The data obtained will be used to calculate the percentage of the sample that contains PIM and which drugs contain the most PIM. Using Microsoft Excel, the data were descriptively analyzed.

RESULTS AND DISCUSSION

A total of 138 elderly outpatients at the Internal Medicine Clinic of Sultan Syarif Mohamad Alkadrie Hospital, Pontianak City, met the inclusion criteria from January to June 2020. This study involved more patients in the age group of 60-69 years old or young elderly. Based on Badan Pusat Statistik (2020), the population was dominated by this age group (64.29%). The percentage of elderly patients in the 60 - 69 year age group was 73.2% higher than the 70 - 79 year age group (25.4%) and the > 80 year age group (1.4%). The number of elderly patients (54%) was higher than that of female elderly patients (46%). Male patients risk degenerative diseases two times higher than female patients. Degenerative diseases tend to occur in male patients because of bad lifestyles, such as smoking,

drinking alcohol, diet, lack of physical activity, and obesity. However, female patients also have a risk of PIM, especially those who begin to experience a decrease in estrogen. Menopause women experience a reduction in the production of estrogen and progesterone. The decline in hormone production affects body fat distribution, interfering with the metabolic system (Handajani *et al.*, 2010). A total of 107 (77.5%) elderly patients tend to have comorbidities. The most common disease in elderly patients was Type II diabetes mellitus (68.84%), as presented in Table 1. A study by the World Health Organization (2002) revealed that the most common diseases suffered by the elderly worldwide are cardiovascular disease, hypertension, diabetes mellitus, stroke, chronic obstructive pulmonary disease (COPD), and musculoskeletal conditions (such as arthritis and osteoporosis). Decreased physiological function due to aging causes the elderly to suffer from more than one disease or multi-pathology. On the other hand, decreased body resistance in the elderly is the cause of degenerative problems (Kementerian Kesehatan Republik Indonesia, 2013).

Table 2 shows identifying potentially inappropriate medication prescriptions in elderly patients at the Internal Medicine Clinic of Sultan Syarif Mohamad Alkadrie Hospital, Pontianak, using the Beer's Criteria 2019. Beer's Criteria 2019 was met by 117 prescriptions (84.78 %), while 21 prescriptions (15.22 %) did not meet the criteria. The Beer's Criteria 2019 list contained 198 drug items out of 117 prescriptions. According to a study conducted by Mulyani & Rukminingsih (2020), 265 elderly patients (88.33 %) received prescriptions, with 487 drug items (23.98 %) meeting Beer's Criteria. Drugs listed in Beer's Criteria should be administered with caution, if not avoided, because the risks and side effects outweigh the benefits when used in elderly patients (American Geriatrics Society, 2019). This study supports previous research conducted by Yuliawati *et al.* (2020) using the Beer's Criteria 2015, which revealed that 79.4% of prescriptions met Beer's Criteria. This study includes several drug items in the Beer's Criteria, similar to previous studies Yuliawati *et al.* (2020). Alprazolam, amitriptyline, diazepam, ibuprofen, lansoprazole, meloxicam, diclofenac sodium, ranitidine, and spironolactone are examples of these medications. The similarity of results with a previous study in Beer's Criteria 2019 can be attributed to an update of the Beer's Criteria 2015, indicating some similarities in the category and type of drug that has the potential to PIM.

Based on Table 3, PIM drugs for the elderly reached 74.2% for category 1, 3.5% for category 2, 16.7% for category 3, 3% for category 4, and 2.5% for category 5.

Category 1

In general, drugs in Category 1 should be avoided in elderly patients. Lansoprazole, glimepiride, glibenclamide, alprazolam, diazepam, amitriptyline, diclofenac sodium, ibuprofen, and meloxicam were some of the drugs in this category used in the elderly at Sultan Syarif Mohamad Alkadrie Hospital Pontianak City

Lansoprazole

Lansoprazole is a proton pump inhibitor (PPI) drug. In this study, lansoprazole is a PIM drug of category 1, which is most widely used by the elderly. The percentage of lansoprazole use reached 36.9%. Based on the Beer’s Criteria 2019 recommendations, this drug should not be used for more than eight weeks in high-risk patients, patients with esophagitis, and pathological hypersecretory conditions (American Geriatrics Society, 2019). PPI drugs can cause magnesium deficiency if taken for a long time as these drugs inhibit

the absorption of magnesium (Food and Drug Administration, 2011). Alternative treatment therapy that can be used is H2-receptor antagonist drugs such as cimetidine and famotidine. These drugs do not cause fractures (Yu *et al.*, 2011).

Glimepiride dan glibenclamide

Sulfonylurea drugs such as glimepiride and glibenclamide were mostly prescribed to elderly patients. Glimepiride was used by 19.2 % of elderly patients, while glibenclamide was used by 3.5 %. According to Beer’s Criteria 2019, the use of glimepiride and glibenclamide should be avoided. They have a high risk of causing long-term hypoglycemia in the elderly (American Geriatrics Society, 2019). Sulfonylureas drugs work by lowering blood glucose levels quickly. Besides, these drugs increase HbA1c, causing hypoglycemia, which reduces patients’ awareness (Gumantara & Oktarlina, 2017). Short-acting sulfonylureas such as glipizide are recommended to treat diabetes mellitus in the elderly as they have the lowest risk of hypoglycemia (Marinda *et al.*, 2016).

Table 1. Characteristics of elderly outpatients at Sultan Syarif Mohamad Alkadrie Hospital Pontianak

Characteristics	N = 138	
	Number	Percentage (%)
Age		
a. 60-69	101	73.2
b. 70-79	35	25.4
c. ≥80	2	1.4
Gender		
a. Male	74	54
b. Female	64	46
Comorbidities		
a. Yes	107	77.5
b. No	31	22.5
Main diagnosis:		
a. Type II Diabetes Mellitus	95	68.84
b. Hypertension	11	7.97
c. BPH	2	1.45
d. Dyspepsia	11	7.97
e. Angina Pectoris	2	1.45
f. Hyperuricemia	1	0.72
g. Hemorrhoids	3	2.17
h. Cholelithiasis	2	1.45
i. Heart failure	4	2.9
j. Asthma	2	1.45
k. Osteoarthritis	2	1.45
l. Tuberculosis	2	1.45
m. Kidney failure	1	0.72

Table 2. Distribution of drugs in the beer’s criteria 2019

Distribution of Sample based on the Beer’s Criteria	N= 138	
	Number	Percentage (%)
Drug prescription included in the Beer’s Criteria 2019	117	84.78
Drug prescription outside the Beer’s Criteria 2019	21	15.22

Table 3. Profile of potentially inappropriate medication based on the beer’s criteria 2019

PIM Category	Name of Drugs	N= 198			
		QE	SR	Number	Percentage (%)
Category 1	Lansoprazole	Moderate	Strong	73	36.9
	Glimepiride	High	Strong	38	19.2
	Glibenclamide	High	Strong	7	3.5
	Alprazolam	Moderate	Strong	4	2
	Diazepam	Moderate	Strong	4	2
	Amitriptyline	High	Strong	12	6.1
	Diclofenac Sodium	Moderate	Strong	2	1
	Ibuprofen	Moderate	Strong	2	1
	Meloxicam	Moderate	Strong	5	2.5
Subtotal				147	74.2
Category 2	Cilostazol – Heart failure	Moderate	Strong	3	1.5
	Pioglitazone – Heart failure	High	Strong	1	0.5
	Diclofenac Sodium –	Moderate	Strong	3	1.5
	Kidney failure				
Subtotal				7	3.5
Category 3	Furosemide	Moderate	Strong	21	10.6
	Spirolactone	Moderate	Strong	10	5.1
	Hydrochlorothiazide (HCT)	Moderate	Strong	2	1
Subtotal				33	16.7
Category 4	Dexamethasone – Diclofenac Sodium	Moderate	Strong	2	1
	Methylprednisolone – Ibuprofen	Moderate	Strong	1	0.5
	Alprazolam – Codeine	Moderate	Strong	3	1.5
Subtotal				6	3
Category 5	Spirolactone	Moderate	Strong	3	1.5
	Ciprofloxacin	Moderate	Strong	1	0.5
	Ranitidine	Moderate	Strong	1	0.5
Subtotal				5	2.5
Total				198	100

Notes: QE = quality of evidence; SR = strength of recommendation

Alprazolam dan diazepam

Alprazolam and diazepam are benzodiazepine drugs in category 1 of the Beer’s Criteria 2019 with the same percentage of 2%. Alprazolam and diazepam should be avoided based on Beer’s Criteria as they can increase the risk of cognitive impairment, delirium, falls, and fractures in the elderly (American Geriatrics Society, 2019).

The risk of falls and fractures in the elderly is caused by the side effects of benzodiazepine drugs, such as dizziness, weakness, and drowsiness, which can reduce the patient's concentration and balance (Sukmawati *et al.*, 2016). Benzodiazepine drugs can be replaced with trazodone and low-dose doxepin alternatives. If benzodiazepines must be used, it is necessary to reduce the dose by half and shorten the duration of therapy. During these drugs, side effects should be monitored (Holt *et al.*, 2010).

Amitriptyline

The s of amitriptyline in the elderly has a high risk. The percentage of amitriptyline prescriptions in the elderly reached 6.1% for category 1. Based on Beer’s

Criteria 2019, amitriptyline should be avoided. Amitriptyline can cause anticholinergic solid effects, sedation, and orthostatic hypotension (American Geriatrics Society, 2019). Side effects of anticholinergics on the central nervous system cover cognitive impairment, confusion, hallucinations, and delirium. Anticholinergics also affect the peripheral nervous system, including causing dry mouth, dry eyes, and constipation (Rudolph *et al.*, 2008). If amitriptyline needs to be used in the elderly, it should be administered in low doses to reduce the side effects (Suga *et al.*, 2019).

Diclofenac Sodium, Ibuprofen, and Meloxicam

NSAIDs (Non-Steroid Anti-Inflammatory Drugs) are often prescribed to the elderly. NSAIDs included in the PIM category 1 were 1% diclofenac sodium, 1% ibuprofen, and 2.5% meloxicam. The mechanism of action of the NSAID group is to inhibit the cyclooxygenase-1 and 2 (COX-1 and COX-2) enzymes. The inhibition of the COX enzyme works results in a decrease in the production of prostaglandins (PGE2) and prostacyclin (PGI2), which are inflammatory mediators

(Lovell & Ernst, 2017). Based on Beer's Criteria 2019, NSAIDs should be avoided for long-term use in the elderly as they can cause perforation. Perforation is a hole or wound in the wall of organs such as the stomach, esophagus, small intestine, and large intestine. This drug may increase the risk of gastrointestinal bleeding or gastric ulcers in high-risk age groups (> 75 years old). Elderly patients are advised to take gastroprotective drugs such as misoprostol to reduce the risk of gastrointestinal bleeding if taking NSAID drugs (American Geriatrics Society, 2019).

Category 2

Drugs in category 2 should be avoided if there is a history of certain diseases or if they can cause drug-disease interactions that can worsen the disease's condition. Some of the drugs used in the elderly at the Sultan Syarif Mohamad Alkadrie Hospital in Pontianak in this category included cilostazol, pioglitazone, and diclofenac sodium

Cilostazol – heart failure

The incidence of PIM category 2 in the use of cilostazol in heart failure patients reached 1.5%. Cilostazol works by inhibiting phosphodiesterase 3, causing an increase in cAMP concentration, resulting in platelet aggregation inhibition prostate (Shinohara, 2010). Beer's Criteria 2019 recommends avoiding using cilostazol in heart failure patients with a reduced ejection fraction. The use of cilostazol can increase the risk of death in the elderly with heart failure (American Geriatrics Society, 2019). An alternative therapy that can be used is pentoxifylline which can improve blood flow by reducing blood viscosity (Utami *et al.*, 2016).

Pioglitazone – heart failure

Pioglitazone is a drug in category 2 used in the elderly with heart failure. The use of pioglitazone in elderly with heart failure reached 0.5%. Based on the Beer's Criteria 2019, this drug should be used with "caution" in asymptomatic heart failure patients and should be avoided in symptomatic heart failure patients (American Geriatrics Society, 2019). Pioglitazone works by binding to PPAR-gamma to increase sensitivity to insulin (Tjokroprawiro, 2015). The use of pioglitazone in patients with heart failure can increase fluid retention, which can worsen heart failure (American Geriatrics Society, 2019).

Diclofenac sodium – kidney failure

Prescription of NSAIDs is included in category 2 as these drugs can worsen the condition of kidney failure in elderly patients. NSAIDs can worsen kidney failure due to the inhibition of prostaglandin synthesis, resulting in the renal medulla. The use of NSAIDs can

also increase sodium retention. In this study, the prescription of the NSAID group for elderly patients with kidney failure reached 1.5% for diclofenac sodium. Paracetamol is the safer alternative for elderly patients with kidney failure (Pham *et al.*, 2009; Supadmi & Hakim, 2012).

Category 3

Category 3 is drugs that should be used with "caution". Prescriptions for the elderly in category 3 are diuretic drugs. A study conducted by Lutfiyati showed that diuretics were widely prescribed in elderly patients (21.18%) (Lutfiyati *et al.*, 2017). Diuretic drugs in PIM incidence in this category reached 10.6% for furosemide, 5.1% for spironolactone, and 1% for hydrochlorothiazide (HCT).

The diuretic drugs work to increase the excretion of sodium, water, and chloride, which then reduce blood volume and extracellular fluid. The diuretic drugs have to be administered with 'caution' as they can cause hyponatremia or SIADH (Syndrome of Inappropriate Antidiuretic Hormone Secretion) (Suryatenggara & Astrawinata, 2018). The use of diuretic drugs in the elderly should be followed by monitoring sodium levels (American Geriatrics Society, 2019).

Category 4

Drugs in category 4 should be avoided because they can cause drug-disease interactions. Dexamethasone, diclofenac sodium, methylprednisolone, ibuprofen, alprazolam, and codeine were among the drugs in this category 4 used in elderly patients at Sultan Syarif Mohamad Alkadrie Hospital in Pontianak.

Corticosteroids - NSAIDs

The incidence of PIM in the corticosteroid-NSAID group reached 1% for dexamethasone-diclofenac sodium and 0.5% for methylprednisolone-ibuprofen. Based on Beer's Criteria 2019, corticosteroids-NSAIDs should be avoided. Concomitant use of corticosteroids-NSAIDs can increase the risk of gastrointestinal adverse events such as peptic ulcer, dyspepsia, gastrointestinal bleeding, and gastritis (American Geriatrics Society, 2019). The potential for gastrointestinal disturbances due to the combined use of NSAIDs with corticosteroids was only caused by the COX-1 enzyme. This effect can occur due to the corticosteroids' mechanism, which inhibits arachidonic acid by phospholipases so that prostaglandins are not formed. Prostaglandins function as gastrointestinal protectors, so if the formation of prostaglandins is inhibited, it can increase the potential for gastrointestinal disorders. Prescription of a COX-2 selective NSAID is recommended if the prescription must be combined with corticosteroids (Moore *et al.*,

2015). If the use of corticosteroids-NSAIDs cannot be avoided, it is recommended to take drugs that can protect the gastrointestinal tract (American Geriatrics Society, 2019).

Opioids - benzodiazepine

The incidence of PIM in the opioid-benzodiazepine class reached 1.5% for alprazolam-codeine 3. Based on the Beer's Criteria 2019, the combinations of opioid-benzodiazepine drugs should be avoided as they can increase the risk of overdose (American Geriatrics Society, 2019). Research conducted by Darke *et al.* (2003) showed that 62% of patients had overdosed due to consuming more than one class of drugs. Overdose due to opioid-benzodiazepine drugs causes respiratory depression, leading to death (Jones *et al.*, 2013).

Category 5

Category 5 is drugs that should be avoided, or the dose should be reduced according to creatinine clearance (CrCl) value. Some drugs in category 5 used in the elderly at the Sultan Syarif Mohamad Alkadrie Hospital, Pontianak were spironolactone, ranitidine, and ciprofloxacin.

Spironolactone

Spironolactone is prescribed for the elderly with creatinine clearance of < 30 mL/min. The prescription of spironolactone in category 5 reached 1.5%. Spironolactone is a potassium-sparing diuretic that acts on the renal tubules. Spironolactone maintains sodium levels in the blood from getting too low, so it can lower blood pressure. Based on Beer's Criteria 2019, the use of spironolactone in the elderly can increase potassium levels or hyperkalemia. A safer alternative is to combine with a thiazide (hydrochlorothiazide) to reduce the loss of potassium ions. If spironolactone should be used, it requires monitoring of the patient's renal function during use (creatinine clearance should not be < 30 mL/min), and dosage adjustments (Fakultas Kedokteran Universitas Sriwijaya, 2004; American Geriatrics Society, 2019).

Ranitidine

The prescription for ranitidine in category 5 reached 0.5% in patients with creatinine clearance of < 50 mL/min. The mechanism of ranitidine is by inhibiting the histamine H₂ receptor which results in inhibition of gastric acid secretion (Fakultas Kedokteran Universitas Sriwijaya, 2004). The use of ranitidine with a conventional dose of 150 mg every 12 hours in the elderly can cause reactions in the central nervous system. The central nervous system reactions cover lethargy, confusion, and drowsiness (Pahwa *et al.*, 2016). The use of ranitidine in elderly patients with

creatinine clearance of < 50 mL/min is recommended at 150 mg every 24 hours (Food and Drug Administration, 2009).

Ciprofloxacin

Ciprofloxacin, a fluoroquinolone antibiotic in the elderly with creatinine clearance of < 30 mL/min, reached 0.5%. Bird *et al.* (2013) showed that ciprofloxacin was the most widely prescribed fluoroquinolone antibiotic in elderly patients (44.5%). Ciprofloxacin causes the risk of acute kidney failure 2.18 times higher than those who do not use ciprofloxacin (Bird *et al.*, 2013). The use of ciprofloxacin can increase the risk of seizures and confusion, so dose adjustments are needed for patients with creatinine clearance of < 30 mL/minute (American Geriatrics Society, 2019). The recommended oral dose of ciprofloxacin in patients with creatinine clearance of < 30 mL/min is 500 mg every 24 hours, and for elderly patients with the creatinine clearance of 30-50 mL/min is 250-500 mg every 12 hours (Lacy *et al.*, 2009).

This study has both strengths and weaknesses. The instrument for assessing drugs in the elderly is vital because it employs Beer's Criteria 2019. Beer's Criteria 2015 has been superseded by this assessment tool. Furthermore, PIM drugs in this study were discussed based on each category in the Beer's Criteria 2019, and treatment recommendations were made. However, this study has several limitations, including the use of laboratory data in clinical assessments and drug use in elderly patients and the use of only serum creatinine data. Other laboratory data, such as sodium, potassium, and albumin protein levels that could lead to PIM risk in elderly patients, were not found in the medical record. Because this study only uses prescription medication from outpatient medical records, the doctor's considerations in prescribing medicine cannot be discovered. Furthermore, the researcher conducted the PIM assessment in this study with no involvement from the doctor who wrote the prescription.

In the future, interviews with doctors could be conducted to determine the factors to consider when prescribing drugs to identify PIM incidence in elderly patients. Other laboratory data such as sodium, potassium, and albumin protein levels can also be used as supporting data in identifying PIM incidence in elderly patients, so the research does not only use creatinine serum patient data.

CONCLUSION

This study concludes that the elderly are at risk of receiving potentially inappropriate drug prescriptions.

Optimizing drug prescribing for the elderly is very necessary. Health care providers must integrate clinical and pharmacological conditions based on Beer's criteria before prescribing to elderly patients. A study implementing the application of the Beer's criteria in healthcare service during hospital admission is warranty.

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AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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