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The Association Between Potentially Inappropriate Medications (PIMs) And Risk Factors In Chronic Kidney Disease Patients At Dr. Moewardi Regional General Hospital, Surakarta

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Abstract

Chronic Kidney Disease (CKD) is one of the most common chronic diseases among geriatric patients and is often accompanied by multiple comorbidities requiring the use of multiple medications (polypharmacy). This condition increases the risk of Potentially Inappropriate Medications (PIMs), defined as medications whose potential risks outweigh their clinical benefits in older adults. Identifying PIMs is essential to improve medication safety and promote rational drug therapy in geriatric patients. This study aimed to determine the prevalence of Potentially Inappropriate Medications (PIMs), identify the associated risk factors, and analyze the relationship between risk factors and PIMs among geriatric patients with chronic kidney disease based on the American Geriatrics Society (AGS) Beers Criteria 2023. This observational analytic study employed a retrospective cross-sectional design. The study included 82 geriatric patients with chronic kidney disease who met the inclusion and exclusion criteria. Data were collected from medical records of patients at Dr. Moewardi Regional General Hospital, Surakarta, from January to December 2025. PIMs were identified using the AGS Beers Criteria 2023, and data were analyzed using univariate analysis and the Chi-Square test with a 95% confidence level. The prevalence of PIMs was 97.6% (80 of 82 patients). Most patients were male (59.8%), aged 60–69 years (57.3%), and received ≥5 medications (57.3%). Category 1 accounted for the highest proportion of PIMs (40.6%), followed by Category 4 (37.8%). The analysis showed that sex, age, comorbidities, and hemodialysis frequency were not significantly associated with PIMs ($p>0.05$), whereas polypharmacy was significantly associated with the occurrence of PIMs ($p<0.05$). The prevalence of Potentially Inappropriate Medications among geriatric patients with chronic kidney disease was very high. Polypharmacy was the only risk factor significantly associated with PIMs. Regular medication review using the AGS Beers Criteria 2023 is recommended to improve medication safety, effectiveness, and rational drug use in geriatric patients.

Keywords: ***Potentially Inappropriate Medications, 2023 Beers Criteria, Chronic Kidney Disease, geriatrics, polypharmacy.***

INTRODUCTION

In Indonesia, chronic kidney disease (CKD) remains a serious health issue with a trend of increasing prevalence year by year. National data indicate that the rise in CKD cases is strongly linked to the high prevalence of non-communicable diseases—specifically diabetes mellitus and hypertension—which are not yet optimally controlled (Ministry of Health of the Republic of Indonesia, 2023). World Health Organization data from 2020 show 254,028 deaths attributed to chronic kidney disease, with the death toll projected to rise by 41.5% by 2040. Kidney disease ranks as the 19th leading cause of death globally, with mortality increasing by 95% between 2000 and 2021 (Patimah et al., 2024). Results from the 2018 Basic Health Research (*Riskesdas*) conducted by the National Institute of Health Research and Development indicate a CKD prevalence of 0.38% (or 3.8 per 1,000 population) in Indonesia, with approximately 60% of patients undergoing hemodialysis (Ministry of Health, 2023). Research by Pernefri in 2018 showed that 198,275 chronic kidney disease patients in Indonesia were undergoing hemodialysis—a twofold increase compared to the previous year (Mait et al., 2021). The Special Region of Yogyakarta records a prevalence of 4.3%, a figure considered high compared to the national average (3.8%). Among hemodialysis patients, the prevalence of fatigue ranges from 60% to 97%, with 70% experiencing severe fatigue (Maulidiyah et al., 2024).

Chronic kidney disease, characterized by a gradual decline in kidney function, is a condition resulting from the progression of kidney failure over several years (Permata et al., 2022). In cases of kidney failure, the body is unable to maintain normal metabolic processes and fluid-electrolyte balance (Putri et al., 2023), a state defined by an estimated glomerular filtration rate (eGFR) of less than 60 mL/min per 1.73 m^2 persisting for approximately three months (Vaidya & Aedulla, 2022). Consequently, the kidneys cannot regulate fluid balance or prevent the accumulation of waste products, leaving the body unable to maintain metabolic, fluid, and electrolyte homeostasis. Interventions such as kidney replacement therapy, hemodialysis, and outpatient care are required to improve the health status of patients with stage 5 chronic kidney disease (Narsa et al., 2022).

Patients with end-stage chronic kidney disease require renal replacement therapy, one form of which is hemodialysis. Hemodialysis is a routine, ongoing therapy designed to maintain the body's metabolic balance. This therapy impacts not only the patient's physical condition but also their psychological and social well-being and overall quality of life (Madania et al., 2021). Hemodialysis cleanses the blood of dissolved substances and toxins and removes metabolic waste products through extracorporeal filtration across a semipermeable membrane using a dialyzer machine. Managing chronic kidney disease via hemodialysis involves a process of adaptation for the patient regarding diet, sleep patterns, rest, daily activities, emotional stress, physical activity limitations, and dependence on the treatment (Rohmaniah & Sunarno, 2022). Hemodialysis is performed twice weekly, with each session lasting three to four hours. The procedure can cause fatigue, discomfort, and cold sweats, all of which impair the patient's quality of life. Consequently, patients undergoing hemodialysis often experience polypharmacy, thereby increasing the risk of inappropriate medication use (Abdu & Satti, 2024).

Polypharmacy can increase the risk of inappropriate medication use, or the use of Potentially Inappropriate Medications (PIMs). PIMs are medications where the risks associated with use outweigh the clinical benefits, particularly in the elderly population. Inappropriate medication use can lead to an increased incidence of adverse drug reactions and drug interactions, as well as worsen a patient's clinical condition (Lee et al., 2023).

In patients with chronic kidney disease, the risk of Potentially Inappropriate Medications (PIMs) is elevated because impaired renal function can affect drug pharmacokinetics, particularly during the elimination phase. Reduced renal capacity to excrete drugs can lead to drug accumulation in the body, thereby increasing the potential for toxicity and adverse effects (Kim et al., 2022). According to Wahyuni & Lestari (2021), studies indicate that factors associated with PIMs include advanced age, the number of medications used, the number of comorbidities, and the duration of patient care. The greater the number of medications used by a patient, the higher the likelihood of inappropriate medication use. Furthermore, patients with multiple comorbidities often require complex drug regimens, which increases the probability of inappropriate medication use. Polypharmacy and the complexity of drug therapy play significant roles in increasing the incidence of PIMs among patients with chronic diseases, including chronic kidney disease (Ofori-Asenso et al., 2021).

The 2023 American Geriatrics Society Beers Criteria are used to identify potentially inappropriate medication use in the elderly population. These criteria serve as widely utilized guidelines in clinical pharmacy research for assessing medication safety in older patients and assisting healthcare professionals in identifying drugs that should be avoided or used with caution (American Geriatrics Society, 2023). According to Kim et al. (2022), several studies indicate that the use of potentially inappropriate medications (PIMs) remains notably high among hospitalized patients with chronic diseases. The high incidence of PIMs underscores the importance of evaluating medication use and identifying the factors contributing to PIM occurrence in patients with chronic kidney disease.

Based on the foregoing, research is needed to determine the relationship between patient risk factors and the occurrence of Potentially Inappropriate Medications (PIMs) in hospitalized patients with chronic kidney disease. The findings of this study are expected to provide insight into the factors

contributing to PIMs, thereby serving as a basis for enhancing medication safety for patients with chronic kidney disease.

RESEARCH METHODS

This study employed a cross-sectional design with a retrospective approach. The data source consisted of medical records from chronic kidney disease patients at Dr. Moewardi Regional General Hospital (RSUD) in Surakarta. A descriptive analysis was conducted to identify the relationship between the occurrence of Potentially Inappropriate Medication and the use of drugs listed in the 2023 Beers Criteria.

RESULTS AND DISCUSSION

Patient Characteristics by Gender and Age

The frequency distribution of geriatric patients with chronic kidney disease by gender and age at Dr. Moewardi Regional General Hospital, Surakarta, is presented in Table 1.

Table 1 Geriatric Patients with Chronic Kidney Disease by Gender and Age

Patient Characteristics	Amount	Percentage (%)
Gender		
Woman	33	40,2%
Man	49	59,8%
Total	**82**	**100**
Age		
60-69 year	47	57,3%
>70 year	35	42,7%
Total	**82**	**100**

Sumber : Data Primer 2025

Based on geriatric patient medical record data from Dr. Moewardi Regional General Hospital (RSUD) in Surakarta covering the period from January to December 2025, a sample of 83 patients was obtained who met the inclusion and exclusion criteria. The majority of the sample consisted of male patients (49 patients; 59.8%) and female patients (33 patients; 40.2%). Regarding age characteristics, the majority of respondents fell into the 60–69 age group (47 patients; 57.3%), while the >70 age group comprised 35 patients (42.7%).

Characteristics based on the number of medications in the prescription

Data collected at Dr. Moewardi Regional General Hospital, Surakarta, covers prescriptions for geriatric patients with chronic kidney disease, with or without comorbid diagnoses. Sample characteristics based on the number of medication items per prescription (polypharmacy and non-polypharmacy categories) are presented in Table 2.

Table 2 Number of Medications for Chronic Kidney Disease Patients

Data Characteristics	Information	Amount	Percentage (%)
Quantity of medication	<5 drug	35	42,7%
	>5 drug	47	57,3%
Total		**82**	**100**

Sumber : Data Primer 2025

Based on Table 4.2, it is evident that the majority of geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, received treatment falling under the polypharmacy category (>5 types of medication)—accounting for 47 prescriptions (57.3%)—while the non-polypharmacy category (<5 types of medication) accounted for 35 prescriptions (42.7%).

Incidence of PIMs Based on Polypharmacy

The identification of PIM occurrences in prescriptions for geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, is presented in Table 3.

Table 3 Identification of PIM Occurrences in Prescriptions for Patients with Chronic Kidney Disease

Data Characteristics	Information	Amount	Percentage (%)
Incidence of PIMs	There were no incidents of PIMs.	21	25,6%
	There was a PIMs incident.	61	74,4%
Total		**82**	**100**

Sumber : Data Primer 2025

Based on Table 4.3, the research results indicate a very high incidence of Potentially Inappropriate Medications (PIMs), affecting 61 respondents (74.4%) out of the 82 prescription samples analyzed, compared to 21 prescriptions (25.6%) where no PIMs occurred.

Incidence of PIMs Based on 2023 Beers Criteria Categories

Based on research data obtained from the analysis of geriatric patients with chronic kidney disease using the 2023 Beers Criteria (presented in Table 4):

Table 4 Classification of PIMs in CKD Patients Based on 2023 Beers Criteria Categories

Category	Information	Amount	Presentage (%)
Category 1	There have been instances of potentially inappropriate medication use among the elderly.	2	1,8%
Category 2	Use of potentially inappropriate medication in the elderly due to drug-disease or drug-syndrome interactions that can exacerbate the disease or syndrome.	24	9,1%
Category 3	Medicines that must be used with caution in the elderly	8	7,3%
Category 4	Drug-drug interactions to be avoided in the elderly	63	57,8%
Category 5	Medications to be avoided or dose-adjusted based on varying levels of renal function in the elderly.	12	11,0%

Sumber : Data Primer 2025

Based on Table 4.4, the categorization of PIMs among geriatric patients at Dr. Moewardi Regional General Hospital (RSUD), Surakarta, during the period of January–December 2025, shows that the highest incidence of PIMs fell under Category 4—drug interactions to be avoided in the elderly—accounting for 63 instances (57.8%). Meanwhile, Category 2 accounted for 24 instances (22.0%), Category 5 for 12 instances (11.0%), Category 3 for 8 instances (7.3%), and Category 1 for 2 instances (1.8%).

Incidence of PIMs Based on the 2023 Beers Criteria

Further identification of the types of medications contributing to the incidence of Potentially Inappropriate Medications (PIMs) in patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, is presented in Table 5.

Table 5 List of Medications Included in the 2023 Beers Criteria

Classification of PIMs	Name of Medication	Number of Incidents (n)	Persentage (%)
Kategory 1	Nikrotaf Retard	2	1,8%
Kategory 2	Ibuprofen 400mg	4	3,7%
	Natrium Diklofenak 50mg	5	4,6%
	Protofein Suppositoria	1	0,9%
	Corsona 4mg (deksametason)	1	0,9%
	Ciprofloxacin 500mg	2	1,8%
	cetirizine 50mg	5	4,6%
	clindamycin 300mg	1	0,9%
	azithromycin 500mg	1	0,9%
	codein HCL 10mg	2	1,8%
	entecavir monohydrate 0,5	2	1,8%
Kategory 3	gabapetin 100mg	4	3,7%
	pletal SR CPS 100mg (cilostazol)	1	0,9%
	ranitidine 150mg	3	2.8%

Kategory 4	adalat oros 30mg	5	4,6%
	omeprazole 20mg	18	16,5%
	furosemide 40mg	15	13,8%
	eperisone HCL 50mg	3	2,8%
	methylprednisolone 4mg	1	0,9%
	kalxetin 10mg (fluoxetine)	1	0,9%
	isosorbid dinitrat (ISDN) 5mg	1	0,9%
	celecoxib 100mg	5	4,6%
	gliquidone	2	1,8%
	spironolaction 100mg	4	3,7%
	lansoprazole 30mg	3	2,8%
	clonidine 0,15mg	2	1,8%
	herbesser CD	1	0,9%
	harnal 0,2mg	2	1,8%
Kategory 5	difenhidramin	2	1,8%
	ketorolac injeksi 30mg/ml	1	0,9%
	natrium phenytoin 100mg	1	0,9%
	clobazam 10mg	1	0,9%
	meloxacim 15mg	1	0,9%
	patral tablet (tramadol+paracetamol)	2	1,8%
	MST Continus 10mg	2	1,8%
	kompolax susp	2	1,8%
	Total	**109**	**100**

Sumber : Data Primer Terolah, 2025

*Note: The total number of incidents (109) may exceed the number of patients (82) because a single patient can receive more than one type of medication classified as a PIM.

The results in Table 5 indicate that the most frequent occurrence of PIMs falls under category 4—drugs that should be used with caution in the elderly according to the 2023 Beers Criteria recommendations. In this study, the drug associated with the highest percentage of PIMs was Omeprazole 20 mg (18 instances; 16.5%), followed by Furosemide 40 mg (15 instances; 13.8%).

Patient Characteristics Based on Hemodialysis Status

The identification of patient characteristics based on hemodialysis status among geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, is presented in Table 6.

Table 6 Identification of Hemodialysis Status Characteristics

Hemodialysis Status	Amount	Presentage (%)
Hemodialysis Therapy	20	24,4%
Not undergoing hemodialysis therapy	62	75,6%
Total	**82**	**100**

Sumber : Data Primer 2025

Based on Table 6, the research results indicate a very high number of patients undergoing hemodialysis—specifically 62 patients (75.6%) out of the 82 identified—compared to the 20 patients (24.1%) who were undergoing the therapy.

Patient Characteristics Based on Hemodialysis Frequency

The identification of patient characteristics based on the frequency of hemodialysis therapy among geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, is presented in Table 7.

Table 7 Patient Characteristics Based on Hemodialysis Therapy Frequency

Hemodialysis Frequency /Mont	Amount	Presentage (%)
0-3x/Bulan	65	79,3%
4-9x/Bulan	17	20,7%
Total	**82**	**100**

Sumber : Data Primer 2025

Based on Table 7, the frequency of hemodialysis therapy among geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta, was determined. The data show that 65 respondents (79.3%) underwent hemodialysis with a frequency of 0–3 times per month, while 17 respondents (20.7%) underwent it 4–9 times per month.

Patient Characteristics Based on CKD Stage

The characteristics of geriatric patients with chronic kidney disease (CKD) at Dr. Moewardi Regional General Hospital, Surakarta, categorized by CKD stage, are presented in Table 8.

Table 8 Patient Characteristics Based on CKD Stage

PGK Stadium	Amount	Presentage (%)
Stadium 1	0	0%
Stadium 2	2	2,4%
Stadium 3	11	13,4%
Stadium 4	19	23,2%
Stadium 5	50	61,0%
Total	**82**	**100**

Sumber: Data Primer 2025

Based on Table 8, the characteristics of geriatric patients with chronic kidney disease (CKD)—categorized by CKD stage—show that the majority of patients were in stage 5, comprising 50 patients (61.0%). This was followed by 19 patients (23.2%) in stage 4, 11 patients (13.4%) in stage 3, and 2 patients (2.4%) in stage 2. Meanwhile, there were no patients in stage 1 (0%). These results indicate that the majority of the geriatric patients participating in the study were already at an advanced stage of chronic kidney disease—specifically, stage 5.

Association between Gender and the Occurrence of PIMs

The analysis of the relationship between gender and the occurrence of Potentially Inappropriate Medications (PIMs) was conducted to determine whether a significant association exists between the gender of geriatric patients with chronic kidney disease and the occurrence of PIMs, based on the 2023 Beers Criteria. The results of the analysis using the Chi-Square test are presented in Table 9.

Table 9 Relationship between Gender and the Occurrence of PIMs

Gender	PIMS Incident	No PIMS Incidents	Total	p-value
Woman	26	7	33	
Man	35	14	49	**0,454**
Total	**61**	**21**	**82**	

Sumber : Data Primer 2025

The Relationship Between Age and the Occurrence of Potentially Inappropriate Medications (PIMs)

An analysis of the relationship between age and the occurrence of Potentially Inappropriate Medications (PIMs) was conducted to determine whether the age groups of geriatric patients with chronic kidney disease were associated with the incidence of PIMs based on the 2023 Beers Criteria. The results of the analysis using the Chi-Square test are presented in Table 10.

Table 4.10 Relationship Between Age and the Occurrence of PIMs

Age	Incidence of PIMs	No PIMs Incidents	total	p-value
60-69 year	36	11	47	
>70 year	25	10	35	**0,596**
total	**61**	**21**	**82**	

Sumber : Data Primer 2025

Association between Comorbidities and the Occurrence of PIMs

An analysis of the relationship between comorbidities and the occurrence of Potentially Inappropriate Medications (PIMs) was conducted to determine whether a significant association exists between comorbidities in geriatric patients with chronic kidney disease and the occurrence of PIMs, based on the 2023 Beers Criteria. The results of the analysis using the Chi-Square test are presented in Table 11.

Table 11 Association between Comorbidities and the Occurrence of PIMs

Comorbidity	Incidence of PIMs	No PIMs Incidents	total	p-value
Comorbidity	43	13	56	
No comorbidities	18	8	26	**0,466**
Total	**21**	**61**	**82**	

Sumber : Data Primer 2025

The Relationship Between Hemodialysis Frequency and the Incidence of PIMs

An analysis of the relationship between hemodialysis status and the occurrence of Potentially Inappropriate Medications (PIMs) was conducted to determine whether there is a significant association between the hemodialysis status of geriatric patients with chronic kidney disease and the incidence of PIMs, based on the 2023 Beers Criteria. The results of the analysis using the Chi-Square test are presented in Table 12.

Table 12 Relationship Between Hemodialysis Frequency and PIMs

Hemodialysis Frequency/Month	No PIMs Incidents	Incidence of PIMs	Total	p-value
0-3x/Mont	19	46	65	
4-9x/Mont	2	15	17	0,142
Total	**21**	**61**	**82**	

Sumber : Data Primer 2025

The Relationship Between Polypharmacy and the Occurrence of PIMs

An analysis of the relationship between polypharmacy and the occurrence of Potentially Inappropriate Medications (PIMs) was conducted to determine whether the use of five or more types of medication is associated with PIMs in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta. The results of the analysis using the Chi-Square test are presented in Table 13.

Table 13 Relationship Between Polypharmacy and the Occurrence of PIMs

Polypharmacy	Incidence of PIMs	No PIMs Incidents	total	p-value
<5 drug	21	14	35	
>5 drug	40	7	47	**0,010**
Total	**61**	**21**	**82**	

Sumber : Data Primer 2025

Association between Hemodialysis Therapy Status and the Occurrence of PIMs

An analysis of the relationship between therapy status and the occurrence of Potentially Inappropriate Medications (PIMs) was conducted to determine whether undergoing hemodialysis therapy is associated with the occurrence of PIMs in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta. The results of the analysis using the Chi-Square test are presented in Table 4.14.

Table 14 Association between Hemodialysis Therapy Status and the Occurrence of PIMs

Hemodialysis Status	Incidence of PIMs	No PIMs Incidents	Total	p-value
hemodialysis therapy	19	1	20	
not undergoing hemodialysis therapy	42	20	62	**0,015**
Total	**61**	**21**	**82**	

Association between CKD Stage and PIMs

An analysis was conducted to determine whether the stage of chronic kidney disease (CKD) is associated with the occurrence of Potentially Inappropriate Medications (PIMs) among geriatric patients with CKD at Dr. Moewardi Regional General Hospital, Surakarta. The results of the analysis using the Chi-Square test are presented in Table 4.15.

Table 15 Association between CKD Stage and PIMs

Stadium	Incidence of PIMs	There were no incidents of PIMs.	p-value
Stadium 1	0	0	
Stadium 2	2	0	
Stadium 3	8	3	**0,770**
Stadium 4	13	6	
Stadium 5	38	12	

Prevalence of Comorbidities in Geriatric Patients with Chronic Kidney Disease

Further identification of comorbidities in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, is presented in Table 16.

Table 16 Prevalence of Comorbidities in Geriatric Patients with Chronic Kidney Disease

Comorbidities	Amount	Presentage (%)
PGK	34	41,5%
Asam urat	4	4,9%
ISK	1	1,2%
DM tipe 2	1	1,2%
Efusi pleura	2	2,4%
Pemfigoid	2	2,4%
Osteoarthiritis	2	2,4%
Pemhigus	1	1,2%
Pruritus	1	1,2%
Syaraf	1	1,2%
Stroke	2	2,4%
Gastritis	3	3,7%
Hipooparatiroidisme	1	1,2%
Pengapuran sendi lutut	2	2,4%
Prostat lunak	1	1,2%
Hyperplasia prostat	1	1,2%
Nyeri punggung bawah	1	1,2%
Hipertensi	1	1,2%
Pelebaran pembuluh darah tengkorak	1	1,2%
Kanker tengkorak	1	1,2%
Aritmia	1	1,2%
Pergeseran tulang belakang	2	2,4%
Kanker leher rahim	3	3,7%
Batu empedu	2	2,4%
Hepatitis C	1	1,2%
Nyeri sendi	1	1,2%
Tungkak lambung	1	1,2%
Lipid	1	1,2%
Kista ginjal	1	1,2%
Penyempitan saluran kencing	1	1,2%
Kanker kandung kemih	1	1,2%
Metastesis sekunder tulang sumsum	1	1,2%
Anemia	1	1,2%
urtikaria	1	1,2%
aneurisma	1	1,2%

Table 16 shows that the most common comorbid condition at Dr. Moewardi Regional General Hospital (RSUD), Surakarta, was Chronic Kidney Disease (CKD).

Discussion

This study aims to determine the relationship between Potentially Inappropriate Medications (PIMs) and risk factors in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta. This is a cross-sectional study utilizing a retrospective approach. Data were obtained from the medical records of geriatric patients with chronic kidney disease treated between January and December 2025 who met the inclusion and exclusion criteria. The total geriatric patient population consisted of 446 individuals. Sample size determination was conducted using Slovin's formula with an error tolerance of 10%. The calculation yielded a minimum sample size of 81.68 patients, which was rounded up to 82 patients. This study included 82 patients who met the inclusion and exclusion criteria, thereby satisfying the minimum sample size requirement.

Patient Characteristics by Gender

Based on medical record data for geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, during the period of January–December 2025, a total of 82 patients met the inclusion and exclusion criteria. The majority of patients were male (n=49; 59.8%), while female patients accounted for 33 individuals (40.2%).

Patient Characteristics by Age

Table 4.1 shows that the majority of respondents fell into the <70 years age group (60–69 years), comprising 47 patients (57.3%), whereas the ≥70 years age group comprised 35 patients (42.7%). These results indicate that the majority of geriatric patients with chronic kidney disease undergoing hemodialysis belonged to the early elderly age group.

Characteristics Based on the Number of Medications per Prescription

Data from the medical records of geriatric patients with chronic kidney disease undergoing hemodialysis at Dr. Moewardi Regional General Hospital (RSUD), Surakarta, revealed that the majority of patients fell into the non-polypharmacy category (<5 medications), comprising 35 patients (42.7%), while 47 patients (57.3%) fell into the polypharmacy category (≥5 medications). These results indicate that a significant proportion of patients in this study received a relatively high number of medications, and polypharmacy remains common among geriatric patients with chronic kidney disease at Dr. Moewardi RSUD, Surakarta.

Incidence of PIMs Based on Polypharmacy

The incidence of Potentially Inappropriate Medications (PIMs) was identified through a review of medical records and medication usage for 82 geriatric patients with chronic kidney disease at Dr. Moewardi RSUD, Surakarta, using the 2023 American Geriatrics Society (AGS) Beers Criteria. The study results showed that 61 patients (74.4%) experienced PIMs, while 21 patients (25.6%) did not. These findings indicate that the incidence of PIMs remains high among geriatric patients with chronic kidney disease.

Incidence of PIMs Based on 2023 Beers Criteria Categories

Analysis of Potentially Inappropriate Medications (PIMs) classified according to the 2023 American Geriatrics Society (AGS) Beers Criteria identified a total of 109 PIM instances among the 82 geriatric patients with chronic kidney disease. As shown in Table 4.5, the highest number of PIM instances occurred in Category 4—drug-drug interactions to be avoided in older adults—accounting for 63 instances (57.8%). This was followed by Category 5 with 12 incidents (11.0%), Category 2 with 24 incidents (22.0%), Category 3 with 8 incidents (7.3%), and Category 1 with 2 incidents (1.8%).

Incidence of PIMs Based on the 2023 Beers Criteria

Based on the analysis of medication use among geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta, during the period of January–December 2025—using the 2023 American Geriatrics Society (AGS) Beers Criteria—a total of 109 instances of Potentially Inappropriate Medications (PIMs) were identified. As shown in Table 4.6, the highest number of PIM instances occurred in Category 4 (drug-drug interactions to be avoided in the elderly), accounting for 63 instances (57.8%). This was followed by Category 2 with 24 instances (22.0%), Category 5 with 12 instances (11.0%), Category 3 with 8 instances (7.3%), and Category 1 with 2 instances (1.8%).

PIM Incidence Based on Hemodialysis Status

Based on medical record data for geriatric patients with chronic kidney disease at Dr. Moewardi RSUD, Surakarta, during the study period of January–December 2025, it was found that the majority of patients (62 patients or 75.6%) were not undergoing hemodialysis therapy, while 20 patients (24.1%) were undergoing hemodialysis. These results indicate that most patients in this study were receiving conservative therapy and did not yet require renal replacement therapy in the form of hemodialysis.

PIM Incidence Based on Hemodialysis Frequency

Based on medical record data for geriatric patients with chronic kidney disease at Dr. Moewardi RSUD, Surakarta, during the period of January–December 2025, the frequency distribution of hemodialysis therapy is presented in Table 4.7. The study results show that the majority of patients underwent hemodialysis therapy 0–3 times per month (65 patients or 79.3%), while 17 patients (20.7%) underwent hemodialysis 4–9 times per month.

Patient Characteristics Based on CKD Stage

Based on a study conducted on 82 geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD) in Surakarta between January and December 2025, it was found that the majority of patients were in stage 5 (50 patients; 61.0%). Additionally, 19 patients (23.2%) were in stage 4, 11 patients (13.4%) in stage 3, and 2 patients (2.4%) in stage 2, while no patients were found to be in stage 1 (0%). These results indicate that the majority of geriatric patients receiving care at the hospital were those with advanced-stage chronic kidney disease.

Association between Gender and the Occurrence of PIMs

Based on Table 4.9, out of 49 male patients, 35 experienced Potentially Inappropriate Medications (PIMs) events, while 14 did not. Meanwhile, among 33 female patients, 26 experienced PIMs events, and 7 did not. The Chi-Square test result showed a p-value of 0.454 ($p > 0.05$); therefore, it can be concluded that there is no significant association between gender and the occurrence of Potentially Inappropriate Medications (PIMs) among geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta.

Association between Age and the Occurrence of PIMs

Based on Table 4.10, in the 61–69 age group, 46 patients experienced Potentially Inappropriate Medications (PIMs) events, while 1 patient did not. Meanwhile, in the ≥70 age group, 34 patients experienced PIMs events, and 1 patient did not. The Chi-Square test results show a p-value of 0.832 ($p > 0.05$); therefore, it can be concluded that there is no significant association between age and the occurrence of Potentially Inappropriate Medications (PIMs) among geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta.

Association between Comorbidities and the Occurrence of PIMs

The study results indicate no significant association between comorbidities and the occurrence of Potentially Inappropriate Medications (PIMs) in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta (p=0.466). These findings suggest that the presence of co-existing conditions does not directly influence the occurrence of PIMs in this patient population. Although patients with comorbidities typically present with more complex clinical conditions and require more diverse therapeutic regimens, the occurrence of PIMs is influenced not only by the number of conditions present but also by factors such as appropriate drug selection, dosage adjustments, and therapeutic monitoring performed by healthcare professionals.

Association between Hemodialysis Frequency and PIMs

The study results indicate no significant association between the frequency of hemodialysis and the occurrence of Potentially Inappropriate Medications (PIMs) in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta (p=0.142). As shown in Table 4.12, among patients undergoing hemodialysis 0–3 times per month, 46 experienced PIMs and 19 did not. Meanwhile, among patients undergoing hemodialysis 4–9 times per month, 15 experienced PIMs and 2 did not.

Association between Polypharmacy and PIMs

Table 4.13 shows that among patients using fewer than five types of medication, 33 experienced Potentially Inappropriate Medications (PIMs) and 2 did not. In contrast, all patients using five or more types of medication—totaling 47 patients—experienced PIMs. The Chi-Square test yielded a p-value of 0.010 ($p<0.05$); therefore, it can be concluded that there is a significant association between polypharmacy and the occurrence of Potentially Inappropriate Medications (PIMs) in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta.

Relationship between CKD Stage and PIMs

The analysis yielded a p-value of 0.770 ($p > 0.05$), indicating no significant association between the stage of chronic kidney disease and the occurrence of PIMs. Although the highest number of PIMs was observed in patients at stage 5, this corresponded to the large number of patients at that stage, and thus did not represent a statistically significant association.

The absence of a significant association indicates that the stage of chronic kidney disease is not a factor that directly influences the occurrence of PIMs. The occurrence of PIMs is influenced more by the appropriateness of drug selection, the number of medications used, and dose adjustments based on renal function than by the disease stage itself. According to KDIGO (2024), all patients with chronic kidney disease require an individualized evaluation of their therapy—regardless of disease stage—to prevent medication-related problems.

CONCLUSION

Based on the research findings and discussion regarding the relationship between Potentially Inappropriate Medications (PIMs) and risk factors in geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital, Surakarta, during the period of January–December 2025, the following conclusions can be drawn:

1. The prevalence of Potentially Inappropriate Medications (PIMs) among geriatric patients with chronic kidney disease at Dr. Moewardi Regional General Hospital (RSUD), Surakarta, was 74.4% (61 out of 82 patients) based on the 2023 American Geriatrics Society (AGS) Beers Criteria. These results indicate that PIMs are frequently encountered in this patient population; therefore, periodic evaluation of medication use is necessary to enhance the safety, effectiveness, and rationality of therapy for geriatric patients.
2. Analysis of risk factors revealed that only polypharmacy and hemodialysis status were significantly associated with the occurrence of PIMs in geriatric patients with chronic kidney disease ($p<0.05$).

All patients taking five or more types of medication experienced PIMs; thus, a higher number of medications used correlates with an increased risk of potentially inappropriate medication use according to the 2023 AGS Beers Criteria. Conversely, factors such as gender, age, comorbidities, frequency of hemodialysis therapy, hemodialysis status, and stage of chronic kidney disease did not show a significant association with the occurrence of PIMs ($p>0.05$).

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