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ORIGINAL RESEARCH

Assessment of Potentially Nephrotoxic Drug Prescriptions in Chronic Kidney Disease Outpatients at a Hospital in Indonesia

Larasati Arrum Kusumawardani[1,2], Hindun Wilda Risni[1,2], Darisa Naurahhanan[1], Syed Azhar Syed Sulaiman[3]

[1]Faculty of Pharmacy, Universitas Indonesia, Depok, Indonesia; [2]Pharmacy Unit, Universitas Indonesia Hospital, Depok, Indonesia; [3]School of Pharmaceutical Sciences, Universiti Sains Malaysia, Pulau Pinang, Malaysia

Correspondence: Larasati Arrum Kusumawardani, Faculty of Pharmacy, Universitas Indonesia, Depok, 16424, Indonesia, Email larasati.arrum@farmasi.ui.ac.id

Background: Nephrotoxic drugs can worsen the kidney function of patients with chronic kidney disease (CKD). There is still a limited amount of research investigating nephrotoxic drugs in Indonesia. This study aims to analyze the prevalence of potentially nephrotoxic drugs (PND) prescriptions and the association of patients' characteristics with PND prescribing.

Methods: This cross-sectional study employed retrospective data from Universitas Indonesia Hospital (RSUI), focusing on CKD outpatients treated between January 2019 and December 2022. CKD patients over the age of 18 were included, with exclusions for those suspected of having CKD, those with a history of kidney transplants, or missing critical data. The study outcome was the prevalence of patients prescribed PND, determined using reliable references to assess potential nephrotoxicity. Furthermore, compliance with clinical guidelines was evaluated at the individual drug level, with each PND within a prescription treated as a separate case. Descriptive analyses were carried out to determine prevalence, which were presented as percentages. Logistic regression analysis was performed to examine the association between patient characteristics and the prescription of PND.

Results: In total, 248 patients were evaluated. The findings revealed that 177 out of 248 patients (71.4%) were prescribed at least one PND. The categories of these drugs included antihypertensives (50.9%), antigout medications (17.8%), antiplatelets (10.5%), antibiotics (9.8%), NSAIDs (5.8%), and antiulcer agents (5.2%). Of 275 cases of PND prescriptions, 220 (80.0%) complied to treatment guidelines, while 55 (20.0%) did not. Logistic regression analysis indicated that patients taking more than four additional medications were more likely to be prescribed PNDs than those on fewer medications (aOR 2.454, 95% CI 1.399–4.305).

Conclusion: Although non-compliance cases are relatively low, PNDs are frequently prescribed to CKD patients, with the risk rising as the number of comedications increases. Measures are needed to ensure guideline compliance, including accurate dosage assessments and outcome monitoring.

Keywords: chronic kidney disease, compliance, nephrotoxic, prescription

Introduction

Chronic kidney disease (CKD) is a disorder of kidney structure or function that lasts for more than three months and has a significant implication for people's health.[1] Nephrotoxic drugs can worsen CKD through various mechanisms, such as changing kidney structure or function.[2] Exposure to nephrotoxic drugs can further reduce kidney function, increase the risk of acute kidney injury (AKI), reduce glomerular filtration rate (GFR) and trigger End Stage Renal Disease (ESRD).[3–5] Individuals with CKD are also at greater risk of experiencing poor outcomes and quality of life.[6,7] Consequently, preventing the use of potentially nephrotoxic drugs (PNDs) by carefully choosing the right medications and dosages, as well as assessing drug combinations, is vital for improving patient therapeutic outcomes.[2,8]

Research in several countries showed that many CKD patients were given nephrotoxic drugs. In Sweden, a community-based study on inappropriate prescribing showed that 18% of CKD patients were prescribed nephrotoxic

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drugs.[9] In Saudi Arabia, a retrospective study evaluating the use of contraindicated medications in patients with renal insufficiency with a computerized clinical decision support system (CDSS) found that 314 patients received at least one nephrotoxic drug and 14% of the drugs were contraindicated, causing a system alert.[10] In Italy, a retrospective study found that 49.8% and 45.2% of CKD patients received at least one prescription for nephrotoxic drugs that are contraindicated in CKD patients in one year before and after the first CKD diagnosis, respectively.[11] In Nigeria, a retrospective study conducted on 201 CKD patients showed that 96% received at least one nephrotoxic drug during the study period.[8] A study in Indonesia revealed that potentially nephrotoxic drugs, including NSAIDs (Nonsteroidal Anti-Inflammatory Drugs), are commonly prescribed to CKD patients.[12]

The 2012 Kidney Disease: Improving Global Outcomes (KDIGO) Clinical Practice Guideline for the Evaluation and Management of CKD was one of the international guidelines for managing patients with CKD.[1] One of the recommendations is to give blood pressure (BP)-lowering drugs to CKD patients with elevated blood pressure and specific levels of albuminuria. Moreover, CKD drug dosing should be adjusted according to GFR. Temporary discontinuation of potentially nephrotoxic and renally excreted drugs is recommended for patients with GFR <60 mL/min/1.73 m² (G3a–G5) during serious illnesses that raise AKI risk.[1,13] The guideline recommendations underscore the complexity of prescribing for CKD patients, highlighting the need for compliance with guidelines to optimize treatment outcomes while minimising harm.

Studies across various diseases and settings in Indonesia have shown that treatments often do not fully align with guideline recommendations.[14–17] The barriers to poor compliance include inadequate guideline dissemination, confusion caused by conflicting national and international guidelines, patient resistance, insufficient professional training, restrictive health regulations, and limited availability or access to drugs.[14,15,17] Given the limited research on the prevalence and guideline compliance regarding nephrotoxic drug prescriptions in CKD patients in Indonesia, conducting further studies in this area is essential. Such research is crucial for evaluating current prescribing practices, improving hospital protocols, and ensuring safer treatment and better outcomes for CKD patients.

Material and Methods

Study Design

This cross-sectional study utilized retrospective data from the Universitas Indonesia Hospital (RSUI). As a type B healthcare facility, RSUI oversees a referral system that includes all primary healthcare services in Depok City, Indonesia. Its advantageous location near the capital city attracts a diverse patient demographic from nearby cities, making it an essential healthcare provider for a broad range of regions.

Sampling and Data Collection

We utilized total sampling to collect data from outpatients who met the specified inclusion and exclusion criteria during the study period. The inclusion criteria included CKD patients aged over 18 years who received treatment between the study period of January 2019 and December 2022. Patients were excluded if they were suspected of having CKD, had a history of kidney transplantation, or had incomplete information regarding their diagnosis, treatments, and GFR. We used secondary data from hospital medical records, including diagnosis, treatment, health professional notes on patients' health progress, and laboratory results. The list of drugs prescribed was collected from treatment notes and integrated patient progress notes (CPPT) within the electronic medical record. Data extraction started from the patient's first visit to RSUI and continued until their final recorded visit within the study period.

We evaluated the severity of patients based on GFR values before patients started PNDs during the study period. GFR is a key measure of kidney function, reflecting the plasma flow from the glomerulus into Bowman's space in the kidney over a specific period; it plays a crucial role in diagnosing, staging CKD, and determining appropriate drug dosages.[18,19] GFR was calculated using the CKD-EPI 2009 formula[20] and classified according to the six KDIGO severity categories,[1] which were condensed into three groups: mild to moderately decreased (stages 1–3b), severely decreased (stage 4), and kidney failure (stage 5). RSUI started to open hemodialysis services in October 2021, so we assessed the history of hemodialysis only between November 2021 and December 2022.

Outcome and Data Analysis

The study outcome was the prevalence of patients prescribed PNDs. Additionally, we assessed the prescribing compliance with clinical guidelines. The prescribed medications were analyzed to check for any that were classified as nephrotoxic drugs, as identified through a literature review from journals listed in PubMed using keywords "nephrotoxic drugs" and "drug-induced kidney injury". From the search, we compiled a list of PNDs drawn from the literature, including works by Ingrasciotta et al, 2014,[11] Al-Naimi et al, 2019;[21] and Kim & Moon, 2012.[22] Two clinical pharmacists reviewed the candidates for PNDs to ensure their applicability to Indonesian healthcare settings. The list of PNDs was then classified based on the drug classes (Supplementary Table 1). The assessment of guideline compliance was based on the Renal Handbook guidelines and KDIGO.[1,23] DN collected data and assessed nephrotoxicity, which was reviewed by two registered pharmacists (LAK and HWR).

We carried out a descriptive analysis to evaluate the prevalence of patients prescribed PNDs and to characterize the profile of these medications. The prevalence was calculated by comparing the number of patients receiving these drugs to the total number of participants in the study, expressed as percentages. Additionally, patients were deemed to have multiple PNDs prescribed when more than one drug was recorded between study periods. Data on multiple PNDs and the number of PNDs within each class were also reported as percentages. Compliance was assessed at the level of individual drugs within each prescription. For prescriptions containing various PNDs, each drug was treated as a separate case and assessed individually for compliance with guidelines. The compliance proportion was calculated by dividing the number of compliant cases by the total number of cases.

We used Odds Ratio (OR) and 95% confidence intervals (CI) to present the association between patient characteristics and prescribing PNDs. The odds ratio is commonly used to illustrate the strength of the association between risk factors and outcomes.[24] We calculated unadjusted (crude) ORs to demonstrate the association between each patient's characteristics and the prescribing of nephrotoxic drugs. Logistic regression was then performed to adjust for all variables to identify the variable most significantly associated with prescribing PNDs, providing aOR (adjusted OR). All analyses were done using IBM® SPSS Statistics version 24.

Results

Patients' Characteristics

The study population included all outpatient CKD patients treated between January 2019 and December 2022, amounting to a total of 523 patients. Of these, 248 patients met the inclusion and exclusion criteria. Table 1 presents patients' characteristics.

Table 1 Patients' Characteristic (n=248 Patients)

Patients' Characteristics	Frequency	Percentage (%)
Gender		
Male	157	63.3
Female	91	36.7
Age (years)		
19–59	92	37.1
≥ 60	156	62.9
Degree of Severity		
Mild to moderately decreased (stage 1–3b)	139	56.0
Severely decreased (stage 4)	59	23.8
Kidney failure (stage 5)	50	20.2
Number of Comorbidities		
0–3	181	73.0
> 3	67	27.0

(*Continued*)

Table 1 (Continued).

Patients' Characteristics	Frequency	Percentage (%)
Type of Comorbidities		
Cardiovascular disease	190	76.6
Type 2 Diabetes Mellitus	117	47.2
Gout and Hyperuricemia	42	17.0
Dyslipidemia	35	14.1
Dyspepsia	23	9.3
Others	161	64.9
Hemodialysis (n=180)		
Received hemodialysis	20	11.1
Did not receive hemodialysis	160	88.9
Number of Other Drugs		
1 to 4	101	40.7
>4	147	59.3

Prevalence of Patients Prescribed Potentially Nephrotoxic Drugs

The prevalence of outpatient CKD patients who were prescribed PNDs at RSUI in the 2019–2022 period is shown in Figure 1.

The results indicated that the prevalence of patients prescribed PNDs was 177 (71.4%). This study also revealed that the minimum number of PNDs received by patients was one, while the maximum was five. The distribution of PNDs prescribed to outpatient CKD patients at RSUI is illustrated in Figure 2.

Profile of Prescribed Potentially Nephrotoxic Drugs for Patients

This study identified 275 PNDs (275 cases) in all prescriptions, encompassing antihypertensives, xanthine oxidase inhibitors, antiplatelets, antibiotics, NSAIDs, and antiulcers. Among these, 220 cases (80.0%) followed the treatment guidelines, whereas 55 cases (20.0%) did not comply, as depicted in Figure 3. The most common drug classes that failed to comply with the guidelines were antigout, followed by antihypertensives, NSAIDs, and antibiotics. Notably, all prescriptions within the antiulcer and antiplatelet groups complied with the treatment guidelines, as shown in Figure 4. The profile of PNDs prescribed to CKD patients and their compliance with treatment guidelines is illustrated in Table 2.

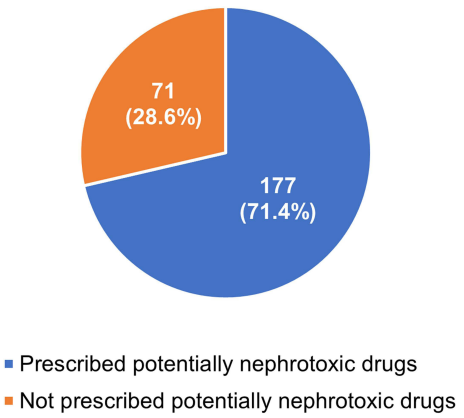

Figure 1 Prevalence of CKD patients prescribed and not prescribed potentially nephrotoxic drugs (n=248 patients).

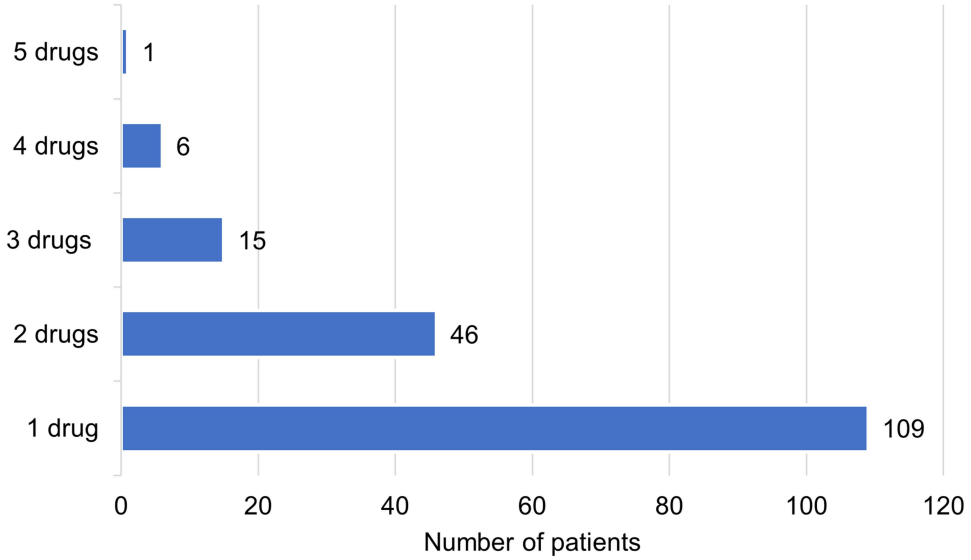

Figure 2 Number of potentially nephrotoxic drugs prescribed to CKD patients (n=177 patients).

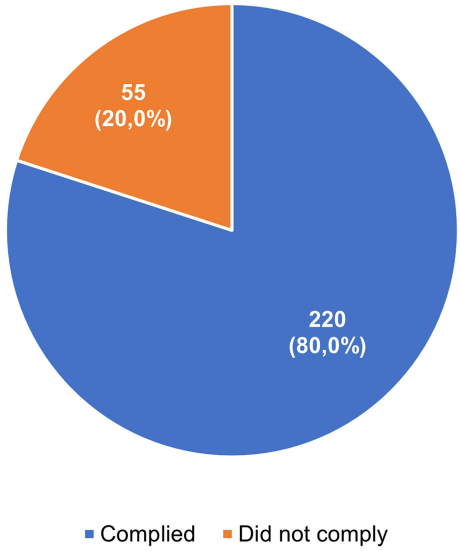

Figure 3 Number of Prescriptions of Potentially Nephrotoxic Drugs that Complied with Guidelines (n=275 cases).

Association Between Patient Characteristics and the Prescription of Potentially Nephrotoxic Drugs

The association between patient characteristics and the prescription of PNDs can be seen in Table 3.

There was a significant difference between the number of other drugs received by patients and the prescribing of PNDs ($p<0.05$). Sex, age, degree of severity, number of comorbidities, and hemodialysis procedures did not show any significant differences in the prescribing of PNDs ($p>0.05$). Logistic regression demonstrated that only the number of other drugs was significantly associated with the prescribing of PNDs (aOR 2.454, 95% CI 1.399–4.305).

Discussion

Among 248 patients, 157 were male (63.3%) and 91 female (36.7%), reflecting 2023 ministry of Health data showing higher kidney failure prevalence in men (0.22%) than women (0.14%).[25] The study further indicated that CKD was more

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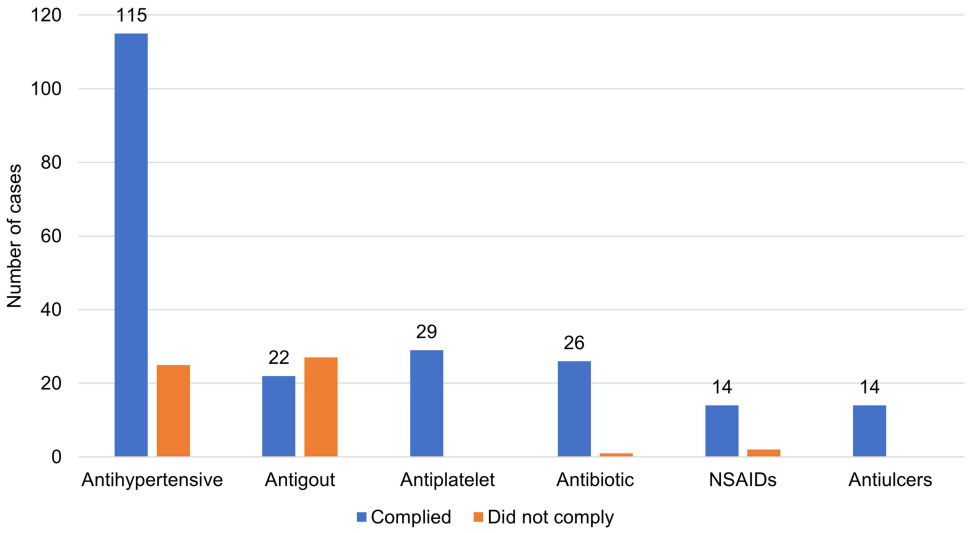

Figure 4 Compliance with Guideline by Drug Classes (n=275 cases).

prevalent in patients aged 60 years and older, in line with data from the 2023 ministry of Health and Centers for Disease Control and Prevention (CDC).[26] Most patients (73.0%) had fewer than three comorbidities, with cardiovascular disease and type 2 diabetes mellitus being the most common, consistent with 2018 data, which identifies hypertension (34.1%) and diabetes mellitus (8.5%) as the main risk factors for CKD in Indonesia.[27]

Table 2 Profile of Prescribed Potentially Nephrotoxic Drugs for CKD Patients (n=275 Cases)

Drug Classes	Frequency, n (%)	Compliance with Guideline		Compliance Assessment Criteria
		Comply	Not Comply	
Antihypertensive	140 (50.9)	115 (41.8)	25 (9.1)	Minimum GFR value
Candesartan	63 (22.9)	54 (19.6)	9 (3.3)	
Ramipril	37 (13.4)	32 (11.6)	5 (1.8)	
Hydrochlorothiazide	20 (7.3)	12 (4.4)	8 (2.9)	
Irbesartan	9 (3.3)	9 (3.3)	0 (0.0)	
Captopril	5 (1.8)	4 (1.4)	1 (0.4)	
Lisinopril	3 (1.0)	2 (0.6)	1 (0.4)	
Valsartan	3 (1.0)	2 (0.6)	1 (0.4)	
Antigout	49 (17.8)	22 (8.0)	27 (9.8)	Dose adjustment based on GFR value
Allopurinol	49 (17.8)	22 (8.0)	27 (9.8)	
Antiplatelet	29 (10.5)	29 (10.5)	0 (0.0)	Strictly monitor
Clopidogrel	28 (10.1)	28 (10.1)	0 (0.0)	
Aspirin	1 (0.4)	1 (0.4)	0 (0.0)	
Antibiotic	27 (9.8)	26 (9.4)	1 (0.4)	Dose adjustment based on GFR value
Cefixime	17 (6.2)	17 (6.2)	0 (0.0)	
Levofloxacin	8 (2.9)	8 (2.9)	0 (0.0)	
Cefadroxil	2 (0.6)	1 (0.4)	1 (0.3)	
NSAID	16 (5.8)	14 (5.2)	2 (0.6)	Minimum GFR value
Sodium Diclofenac	6 (2.2)	6 (2.2)	0 (0.0)	
Etoricoxib	5 (1,8)	3 (1,0)	2 (0.6)	
Ibuprofen	5 (1,8)	5 (1.8)	0 (0.0)	
Antiulcer	14 (5.2)	14 (5.2)	0 (0.0)	Dose adjustment based on GFR value
Ranitidine	14 (5.2)	14 (5.2)	0 (0.0)	

Abbreviations: GFR, Glomerular Filtration Rate; NSAID, nonsteroidal anti-inflammatory drug.

Table 3 Association of Patient Characteristics With Prescription of Potentially Nephrotoxic Drugs

Characteristics	Prescription of Potentially Nephrotoxic Drugs		Total (N=248)	*p-Value*	Unadjusted OR (95% CI)
	Prescribed (%)	Not Prescribed (%)			
Sex					
Male	114 (72.61)	43 (27.39)	157	0.673	1.178 (0.669–2.077)
Female	63 (69.23)	28 (30.77)	91		Ref
Age (years)					
19–59	70 (76.09)	22 (23.91)	92	0.264	1.457 (0.811–2.619)
≥ 60	107 (68.59)	49 (31.41)	156		Ref
Degree of Severity					
Stage 1–3b	94 (67.63)	45 (32.37)	139	0.183	0.654 (0.372–1.152)
Stage 4–5	83 (76.15)	26 (23.85)	109		Ref
Number of Comorbidities					
0–3	126 (69.61)	55 (30.39)	181	0.396	0.719 (0.377–1.370)
> 3	51 (76.12)	16 (23.88)	67		Ref
Hemodialysis (N = 180)					
Hemodialysis	7 (35)	13 (65)	20	0.236	2.002 (0.759–5.280)
Non- hemodialysis	83 (51.87)	77 (48.13)	160		Ref
Number of Other Drugs					
1 to 4	55 (57.9)	40 (42.1)	95	<0.001*	0.349 (0.198–0.616)
>4	122 (79.7)	31 (20.3)	153		Ref

Note: * = statistically significant ($p < 0.05$).
Abbreviations: OR, Odds Ratio; CI, Confidence Interval.

The prevalence of patients prescribed PNDs in this study was 177 (71.4%). Research from other countries has shown varying results. Our findings are notably higher compared to a study conducted in Sweden, where only 18% of CKD patients were prescribed PNDs.[9] In Saudi Arabia, 314 patients received at least one drug that was nephrotoxic and 14% of these drugs were contraindicated.[10] In Italy, 45.2% of patients received at least one nephrotoxic drug that is contraindicated in CKD patients within 1 year after CKD diagnosis.[11] However, research in Nigeria showed that 96% of patients received at least one nephrotoxic drug during the study, which is higher than the result in this study.[8]

Our study revealed that the number of PNDs prescribed to patients varied from a minimum of one to a maximum of five. The concurrent use of multiple nephrotoxic drugs necessitates careful monitoring, as it can elevate the risk of AKI.[28] This risk is especially significant when the drugs have synergistic nephrotoxic mechanisms. These medications may compete for transport proteins and influx or efflux transporters, increasing intracellular concentrations and a greater likelihood of kidney damage.[28,29] Furthermore, this study showed that antihypertensive medications accounted for the highest proportion of PND prescriptions (50.9%), followed by antigout (17.8%). This is likely due to the high prevalence of hypertension and gout among patients with CKD. Both conditions are well-established risk factors for CKD. Hypertension contributes to CKD progression through increased resistance in renal blood vessels, which can cause ischemia and subsequent kidney damage. Furthermore, hypertension can change renal hemodynamics, leading to glomerular hyperfiltration, initially followed by glomerulosclerosis. This cycle exacerbates kidney dysfunction over time.[30] On the other hand, CKD is also the most common cause of secondary hypertension because of some molecular mechanisms, such as salt and volume expansion, sympathetic nervous system hyperactivity, upregulated renin-angiotensin aldosterone system (RAAS), oxidative stress, vascular remodelling, or endothelial dysfunction.[31] Similarly,

gout is associated with hyperuricaemia, which can cause renal tubular injury, interstitial inflammation, and precipitation of urate crystals in the kidneys.[21,32] In addition, hyperuricemia leads to the development of hypertension or a marker of metabolic syndrome and diabetes, which are generally understood as risk factors for CKD.[32]

KDIGO 2012 recommends prescribing antihypertensive to CKD patients with high blood pressure and specific levels of albuminuria. While albuminuria is important in this context, we could not obtain the data because albumin examination has not been a routine test in RSUI. Additionally, temporary discontinuation of PNDs is recommended for patients with GFR <60 mL/min/1.73 m² during serious illnesses that raise AKI risk. KDIGO further provided tables of cautionary notes, including the GFR cut-off for some nephrotoxic drugs.[1] We combined this reference with The Renal Drug Handbook[23] to assess the appropriateness of the drug prescribing and considered them as complying and not complying with the guideline. Out of the 275 cases of nephrotoxic drug prescriptions, 220 cases (80.0%) complied with treatment guidelines, while 55 cases (20.0%) did not comply. The high level of compliance in this study suggests that patients may require the PNDs for their treatment despite the associated risks. This study highlights the critical importance of close monitoring to ensure that patients derive more benefit than harm from the use of PNDs, minimizing the risk of adverse kidney outcomes. It is important to note that we did not assess the clinical impact of noncompliance. However, evidence showed that inappropriate prescription of PNDs in CKD patients can lead to adverse effects, such as further kidney injury and metabolic derangements.[33] Other study also suggests that underlying CKD and the single or cumulative dose of the PNDs, along with factors such as age, concurrent nephrotoxic exposures, patient-specific characteristics, care process factors, and disease-specific factors, can collectively contribute to drug-induced AKI.[34]

Other than ensuring that patients require PNDs for their conditions, assessing treatment compliance is crucial in identifying why PND prescriptions may not align with established guidelines. In this study, antigout and antihypertensive are among the drug classes with a high percentage of noncompliance. The Renal Drug Handbook mentioned dosage adjustments for antigout based on the patient's GFR.[23] Meanwhile, for antihypertensives, a minimum GFR value is often required for safe prescribing.[1] Although our study did not specifically investigate the underlying challenges, we hypothesize that several factors may contribute to this noncompliance, including knowledge and awareness gaps,[35] the complexity of dosage adjustments, and institutional barriers. For example, the absence of local guidelines tailored to CKD management may be one challenge. An Indonesian guideline for CKD was just published in late 2023,[36] with the previous guideline from 2017 focused on end-stage renal disease (ESRD).[37] Furthermore, the lack of routine albuminuria testing alongside GFR measurements to guide antihypertensive prescriptions and under-recognized patients with CKD by healthcare providers[33] present additional barriers. To address these issues, it is essential for hospitals to expand their testing facilities, develop comprehensive clinical pathways, and training.[35] Such measures would enhance compliance with guidelines and optimise patient outcomes. Some studies propose that the use of scoring assessment risk, utilization of electronic alert or decision support system,[34,38] research of novel biomarkers, development of artificial intelligence algorithm[39] could help healthcare providers prevent kidney damage induced by drugs. Conversely, others argue that clinical decision support has its limitations, as it remains affected by prescribers' reluctance to adjust drug dosages and their preference for traditional practice patterns, highlighting the need for physician-targeted interventions[40] and integrated multidisciplinary collaboration among medical professionals.[41]

The univariate test showed no significant difference between sex and the prescription of PNDs (p=0.673), consistent with studies in Nigeria (p=0.590) and Saudi Arabia (p=0.27).[8,10] This suggests that male and female patients have similar risks of being prescribed these drugs. Additionally, no significant difference was found between age and the prescription of PNDs (p=0.264), a finding aligned with Nigerian research (p=0.704)[8] but differing from Saudi Arabia,[10] where age showed a significant impact (p<0.001). Variations in age groupings may explain these discrepancies. Additionally, no significant differences were observed regarding CKD severity (p=0.183), the number of comorbidities (p=0.396), or hemodialysis status (p=0.236) in relation to the prescription of nephrotoxic drugs. However, patients taking more than four other medications were significantly more likely to receive PNDs (p<0.01). This indicates that polypharmacy increases the likelihood of nephrotoxic drug prescriptions.

The logistic regression also indicated that patients receiving more than four other drugs were more likely to be prescribed PNDs. This suggests that polypharmacy may serve as a predictive factor for nephrotoxic drug prescription, prompting health professionals to be more cautious with such patients. Polypharmacy, defined as the use of multiple

medications, is well-known to increase the risk of adverse effects. This study further highlights that patients with polypharmacy may face a heightened risk of additional adverse effects due to the increased likelihood of nephrotoxic drug prescriptions. However, this analysis was limited by the number of covariates available in the data. Further research involving a broader range of covariates is necessary to validate these findings.

This study has several limitations. As it is based on observational retrospective data, we could not collect complete information. Patients with critical missing data, such as absent diagnoses, treatments, and GFR measurements, were excluded from the analysis. These exclusions -necessary for defining our study population, exposures of interest, and dosage assessments- may have introduced selection bias, potentially leading to an underestimation or overestimation of prevalence. However, we believe much of the missing data occurred completely at random, thereby minimising the risk of selection bias. The retrospective design and reliance on secondary data also limited our ability to confirm the indications or rationale behind physicians' prescribing decisions. Nonetheless, we sourced data directly from medical records, and nephrotoxicity assessments were reviewed by clinical pharmacists to enhance reliability. Additionally, we were unable to collect other important covariates, such as socioeconomic status or healthcare accessibility, to evaluate the risk factors for prescribing nephrotoxic drugs. However, all patients in the study were covered by national insurance, which mitigated some disparities in healthcare accessibility.

Conclusion

In this study, we found that the prevalence of PND prescriptions among CKD patients was notably high, with 71.4% of patients receiving at least one nephrotoxic drug. Out of 275 cases of nephrotoxic drug prescriptions, 220 cases (80.0%) complied with treatment guidelines, while 55 cases (20.0%) did not. We did not observe any significant associations between sex, age, CKD severity, comorbidities, or hemodialysis status and the prescription of PNDs. However, patients taking more than four other medications were more likely to be prescribed nephrotoxic drugs, suggesting that polypharmacy may be a predictive factor.

Although non-compliance cases are relatively low, the prevalence of patients receiving PNDs remains significant, emphasising the need for prescribers to follow guidelines through proper dosage assessments and patient monitoring. With Indonesia's CKD management guideline published in 2023, it is crucial to prioritise its dissemination and provide comprehensive education. Implementing decision support systems, such as disease-specific clinical pathways and digital clinical tools integrated with medical resources and references, is strongly recommended to improve compliance and patient outcomes.

While this study offers valuable insights into prescribing patterns of PNDs, further research utilizing more robust methodologies is necessary to validate these findings. Investigation about reasons for and clinical impact of non-compliance as well as additional factors influencing PNDs prescriptions in CKD patients are strongly recommended.

Ethics Approval and Informed Consent

The study adhered to the Declaration of Helsinki and was conducted following ethical approval from the institutional review board of RSUI (No. S-016/KETLIT/RSUI/III/2023) with protocol number 2023-03-224. Informed consent was waived by the institutional review board as the study did not involve direct interaction with patients, relying solely on secondary data for analysis.

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Disclosure

The author(s) report no conflicts of interest in this work.

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