
Evaluation Of The Rationality Of Antibiotic Use In Hospitalized Adult Patients With UTI Diagnosis On Clinical Outcome At Dr. Moewardi Regional Hospital

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Abstract

Urinary Tract Infection (UTI) is a common infection with high antibiotic resistance due to irrational use. To assess the rationality of antibiotics in adult inpatients with UTI at Dr. Moewardi Regional General Hospital using the Gyssens method, ATC/DDD patterns, and their relationship with clinical outcomes. A retrospective descriptive observational study of medical records of 50 acute pyelonephritis patients (population 270, Slovin sample $e=10\%$, consecutive sampling), collected in December 2025. LPD medical records; analysis: Gyssens (qualitative Permenkes 28/2021), ATC/DDD (quantitative), Fisher's Exact ($p<0.05$). 64% female, 52% >60 years; ciprofloxacin 90%; rationality 46% (Gyssens category 0), 54% irrational (mainly short duration 44%); ATC/DDD: ciprofloxacin 47.2%, ceftriaxone 52.8%; outcome improved 94%; $p=0.090$ (not significant). Rationale was low, especially for duration, with no significant association with outcome; stewardship is recommended to prevent resistance.

Keywords: Antibiotics, Atc/Ddd, Gyssens Method, Rationality, Urinary Tract Infection.

INTRODUCTION

Urinary Tract Infections (UTIs) are one of the most common infections globally, second only to respiratory infections, with a prevalence reaching millions of cases annually. According to data from the World Health Organization (WHO) through a study of the global burden of disease, in 2021 there were approximately 8.56 million new cases of UTI with a standard prevalence rate of 105.35 per 100,000 population, which continues to increase over time. In Indonesia, the Ministry of Health recorded 90-100 cases per 100,000 population per year, with a higher incidence in adult women (50-60% experience at least one episode) and postmenopausal women (around 10%), as reported by Sifa and Siswanto (2025).

UTIs often affect various age groups, but their prevalence increases significantly in those over 40 years of age, especially the 50-59 year old group as the most sufferers, which can lead to serious complications and even death if not treated promptly. Research by Shirby and Soeliongan in Lucitania Floreca Mokos et al. (2023) and Belete (2020) and Vasudevan (2019) in Unok and Mangawing (2024) confirms this risk due to multi-resistant pathogens.

The dominant empirical use of antibiotics for UTI, such as fluoroquinolones (35%), cephalosporins (27%), and penicillin (16%) based on the study by Wagenlehner et al. (2016) in Unok and Mangawing (2024), is often irrational, with 30% of irrational cases at Prof. Dr. WZ Johannes Kupang Regional General Hospital (Amrullah et al., 2022). This contributes to increasing antimicrobial resistance, where 57% of initial UTI cases are resistant to one or more antibiotic classes, rising to 65% in recurrent infections.

The problem is further complicated by the fact that therapy without bacterial susceptibility testing leads to ineffective treatment, with local studies showing only 46-70% efficacy using the Gyssens method in Indonesian hospitals. Furthermore, broad-spectrum antibiotic use is prevalent without quantitative evaluation such as ATC/DDD, potentially worsening clinical outcomes.

This study aims to assess the level of rationality of antibiotic use in adult inpatients diagnosed with UTI at Dr. Moewardi Regional General Hospital using the Gyssens method, analyzing usage patterns based on ATC/DDD, and exploring its relationship with clinical outcomes. The urgency lies in preventing the increasing antibiotic resistance in Indonesia, where irrational use is correlated with higher mortality, so that the results of this study can be the basis for antibiotic stewardship

interventions to optimize therapy. The novelty of this study is the integration of the Gyssens evaluation with ATC/DDD and the analysis of its direct relationship with clinical outcomes in a referral hospital in Central Java, complementing previous studies that were limited to descriptions of rationality only.

RESEARCH METHODS

This is a descriptive observational study with a retrospective approach, where data were collected from the medical records of adult inpatients diagnosed with Urinary Tract Infection (UTI) at Dr. Moewardi Regional General Hospital to evaluate the rationality of antibiotic use using the Gyssens method, analyze usage patterns through the ATC/DDD system, and examine its relationship with clinical outcomes. This approach was chosen because it allows for efficient analysis of historical data without prospective intervention, in accordance with health research principles that emphasize the validity of secondary data from medical records. The Gyssens method is categorized into 0 (rational) to VI (incomplete data), with reference to the Guidelines of the Minister of Health Regulation No. 28 of 2021, while ATC/DDD calculates antibiotic consumption using the formula of the number of grams divided by the WHO DDD, complementing qualitative and quantitative evaluations as in similar studies in Indonesian hospitals.

The main instrument was a data collection sheet (DPL) from patient medical records, covering identity, diagnosis, antibiotic therapy (type, dose, interval, duration), and clinical outcome (improved or not improved based on the EAU Guideline 2024), which was validated through editing, coding, entry, and cleaning using software such as SPSS. Analysis techniques included qualitative for Gyssens (evaluation of the appropriateness of indications, drugs, doses, etc.), quantitative for ATC/DDD (descriptive DDD tables per patient), and inferential using Fisher's Exact test ($p < 0.05$ significant) for the Gyssens-outcome relationship. This mixed methods approach ensured data triangulation, increasing the reliability of the results as recommended in clinical pharmacy research design.

The population was 270 inpatients with UTI at Dr. Moewardi Regional General Hospital between January and June 2025, with an accessible population of 200 patients after initial inclusion (adults ≥ 18 years, hospitalized, on antibiotic therapy, with complete records). The sample was calculated using the Slovin formula ($n = N / (1 + N e^2)$, $e = 10\%$) resulting in a minimum of 67 patients via consecutive sampling, then excluding urosepsis and CAUTI up to 50 patients with acute pyelonephritis; inclusion criteria included complete therapy data, exclusion of pregnancy, children, death, and incomplete records. This strategy ensured representativeness and reduced selection bias according to observational research standards.

Data collection was conducted in December 2025 at Dr. Moewardi Regional General Hospital through the following stages: (1) identification of UTI patients from medical records meeting inclusion criteria; (2) recording of record numbers, identity, clinical, and therapy; (3) transcription to LPD; (4) Gyssens analysis (qualitative vs. Permenkes 2021), ATC/DDD (quantitative Excel), and Fisher's Exact for outcome relationships. The process was ethically supervised with completeness checks to avoid bias, followed by descriptive and inferential reporting. This procedure was systematic, ensuring retrospective data traceability as in UTI antibiotic rationality studies.

RESULTS AND DISCUSSION

Patient Characteristics By Gender

Table 1. Urinary Tract Infection Patients Based on Gender

Gender	Number of Patients	Percentage (%)
Man	18	36
Woman	32	64
Amount	50	100

By Age

Table 2. Urinary Tract Infection Patients Based on Age

Age (Years)	Number of Patients	Percentage (%)
19 – 40 years old	9	18
41 – 60 years	15	30
> 60 years	26	52
Amount	50	100

Distribution of Antibiotic Use

Table 3. Distribution of Antibiotic Use

Clinical Diagnosis	Antibiotic Name	Route of Administration	Number of Patients	Percentage (%)
Acute	Ciprofloxacin	iv	45	90
Pyelonephritis	Ceftriaxone	iv	5	10
	Total		50	100

Evaluation of Antibiotic Use Using the Gyssens Method

Table 4. Results of Evaluation of Antibiotic Use with the Gyssens Method

Gyssens Category	Number of Patients	Percentage (%)
Rational		
Category 0 (appropriate use of antibiotics)	23	46
Irrational		
Category VI (incomplete data)	0	0
Category V (no indication for antibiotic administration)	0	0
Category IV A (more effective antibiotics)	0	0
Category IV B (less toxic/safe antibiotics)	0	0
Category IV C (lower cost antibiotics)	0	0
Category IV D (narrower spectrum antibiotics)	0	0
Category III A (antibiotic administration for too long)	4	8
Category III B (antibiotic administration too short)	22	44
Category II A (inappropriate antibiotic dose)	1	2
Category II B (inappropriate antibiotic administration interval)	0	0
Category II C (inappropriate route of antibiotic administration)	0	0
Category I (inappropriate timing of antibiotic administration)	0	0
Total	50	100

Category IIIA (Prolonged antibiotic administration)

Table 5. Category III A (Prolonged antibiotic administration)

Category	Antibiotics given	Duration of administration	2021 Minister of Health Regulation	Number of patients	Percentage (%)
IIIA	Ciprofloxacin IV	9 days	7 days	3	6
	Ciprofloxacin IV	12 days	7 days	1	2
	Total			4	8

Category IIB (Too short course of antibiotics)

Table 6. Category IIB (Too short antibiotic administration)

Category	Antibiotics given	Duration of administration	2021 Minister of Health Regulation	Number of patients	Percentage (%)
IIB	Ciprofloxacin IV	3 days	7 days	11	22
	Ciprofloxacin IV	4 days	7 days	3	6
	Ciprofloxacin IV	5 days	7 days	3	6
	Ciprofloxacin IV	6 days	7 days	4	8
	Ceftriaxone IV	5 days	7 days	1	2
		Total		22	44

Category IIA (Use of antibiotics at inappropriate dosage)

Table 7. Category IIA (Use of antibiotics at inappropriate dosage)

Category	Antibiotics given	Dosage	2021 Minister of Health Regulation	Number of patients	Percentage (%)
IIA	Ceftriaxone IV	1 gram	2 grams	1	2

Category 0 (Proper and appropriate use of antibiotics)

Table 8. Category IIA Category 0 (Use of antibiotics appropriately and appropriately)

Antibiotics	Dose/interval/route	Duration of administration	Number of patients	Percentage (%)
Ciprofloxacin	400 mg/per 12 hours/iv	7 days	20	40
Ceftriaxone	2 grams/per 24 hours/iv	7 days	3	6
		Total	23	46

Antibiotic Evaluation Using the ATC/DDD Method

Table 9. Quantity of Antibiotic Use

ATC Code	Antibiotics	WHO DDD	Total DDD	DDD/100 patient days	%DDD/100 patient days
J01MA02	Ciprofloxacin	0.8 grams	251.75	96	47.2
J01DD04	Ceftriaxone	2 grams	35.5	107.6	52.8
		Total		203.6	100

**Antibiotic Evaluation Using the ATC/DDD Method
 Patient Characteristics Based on Clinical Outcomes**

Table 10. Patient Characteristics Based on Clinical Outcomes

Clinical Diagnosis	Outcome	Clinical Definition	Number of Patients	Percentage (%)
Acute Pyelonephritis	Getting better	Improvement in clinical symptoms and declared home in stable condition	47	94
	Not Getting Better	There is no improvement in clinical condition, there are symptoms and the condition is not yet stable	3	6
Total			50	100

Analysis of the Relationship Between the Rationality of Antibiotic Use

Table 11. Relationship Between Rationality and Patient Clinical Outcomes

Rationality	Clinical Outcome		Total	p-value
	Getting better	Not Getting Better		
Rational	20 (87%)	3 (13%)	23	0.090
Irrational	27 (100%)	0 (0%)	27	
Total	47	3	50	

DISCUSSION

Patient Characteristics

Research by Riarti FN et al. (2021), which reported that the percentage of female patients reached 67%, while the percentage of male patients was 33%, aligns with the results of this study. The high incidence of UTIs in women may be influenced by anatomical and physiological factors. Anatomically, the female urethra is shorter than the male urethra, resulting in a shorter entry distance for microorganisms to reach the bladder. This condition makes it easier for bacteria to enter and grow in the urinary tract. Furthermore, the proximity of the female urethra to the anus also increases the likelihood of bacterial contamination.(Tandari et al., 2016)These factors cause women to have a higher risk of experiencing urinary tract infections than men.(Amrullah et al., 2022).

Research by Czajkowski et al., 2021 and Patrick et al., 2021, which showed that urinary tract infections (UTIs) are common in women, especially those of productive age and the elderly, aligns with this study. In women of productive age, sexual activity is a factor that can increase the risk of UTIs because it facilitates bacterial entry into the urethra. Meanwhile, in the elderly, the risk of UTIs tends to increase with age due to declining organ function, including the urinary tract. The elderly also often experience difficulty emptying the bladder completely or experience urinary incontinence, resulting in urine retention and becoming a breeding ground for bacteria.(Sari, 2016). Furthermore, a declining immune system in old age makes them more susceptible to infections, including urinary tract infections. This puts women of childbearing age and the elderly at a higher risk of developing UTIs.(Oktaviani et al., 2025).

Distribution of Antibiotic Use

The high prescription of ciprofloxacin antibiotics is based on ciprofloxacin being the antibiotic of first choice in patients with acute pyelonephritis based on Minister of Health Regulation Number 28 of 2021 and is one of the antibiotics widely used in the management of urinary tract infections, especially those caused by *Escherichia coli*, *Klebsiella pneumoniae*, and coagulase-negative *Staphylococcus* bacteria. This antibiotic has a broad spectrum of action with high potency against gram-negative bacteria, especially the Enterobacteriaceae group which is known to be the main cause of urinary tract infections, so ciprofloxacin is still used as an alternative in the treatment of these infections. (Paluseri et al., 2022; Restyana and Admaja, 2019)

A study conducted at a hospital in Bandung and published in the Pahlawan University Journal showed that the most commonly used antibiotic in patients with urinary tract infections (UTIs) was ciprofloxacin, at 42.21%, followed by cefixime at 30.52%. These findings indicate that quinolone and cephalosporin antibiotics remain the primary choices in clinical practice for treating UTIs. The high use of these two antibiotic classes reflects clinicians' tendency to choose empiric therapy with a broad spectrum and good activity against UTI-causing bacteria.

In general, ciprofloxacin and ceftriaxone are among the antibiotics frequently prescribed for UTI management, both in hospitals in Indonesia and in international studies. Both antibiotics are effective against Gram-negative bacteria, particularly *Escherichia coli*, which is known to be the most common cause of urinary tract infections. In addition to *E. coli*, other bacteria such as *Klebsiella pneumoniae* and several members of the Enterobacteriaceae have also shown sensitivity to these two antibiotics, making them a rational choice for empirical therapy, particularly in cases of moderate to severe UTI or those requiring inpatient care.

The use of ciprofloxacin, a quinolone, is supported by its ability to achieve high therapeutic concentrations in urinary tract tissues and good bioavailability. Meanwhile, ceftriaxone, a third-generation cephalosporin, has the advantages of a broad spectrum of action and ease of intravenous administration in hospitalized patients with more severe clinical conditions. This is in line with various national and international clinical guidelines that recommend quinolones or third-generation cephalosporins as the therapy of choice for acute pyelonephritis and complicated UTIs. (Mark et al., 2021).

Thus, the distribution of antibiotic use, dominated by quinolones and cephalosporins in various studies, demonstrates consistency between clinical practice and recommended therapy guidelines. However, antibiotic selection still requires consideration of local bacterial resistance patterns, the patient's clinical condition, and the principles of rational antibiotic use to minimize the risk of future resistance. (Selifiana et al., 2023).

Evaluation of the Rationality of the Gyssens Method

Antibiotic use is considered rational if it is classified into category 0 based on the Gyssens method, which refers to the guidelines of the Minister of Health of the Republic of Indonesia Regulation Number 28 of 2021. Meanwhile, irrational antibiotic use includes antibiotics that fall into categories other than category 0. The assessment of antibiotic use in this study was carried out by following the previously established Gyssens flow.

The assessment process begins with the first stage, category VI, where medical record data is incomplete for analysis, including patient name, age, gender, diagnosis, antibiotic name, dose, duration, interval, and route. The evaluation results indicate that the analyzed medical record data is complete and can be analyzed, allowing for further analysis.

The next category is Category V, which refers to antibiotics without a clear indication. The evaluation results indicate that the antibiotics administered were appropriate for the patient's diagnosis of a urinary tract infection, which included fever, flank pain, weakness, nausea, or vomiting. Therefore, the assessment proceeded to the next category.

The next category, category IV A, involves the presence of a more effective antibiotic option than the prescribed one. This occurs when the antibiotic used is not included in the treatment line

recommended by Minister of Health Regulation No. 28 of 2021. The evaluation results showed that the antibiotics administered were in accordance with national guidelines, namely, first-line treatment for acute pyelonephritis is ciprofloxacin intravenously and second-line treatment is ceftriaxone intravenously. (Ministry of Health Regulation, 2021). Then the assessment category continues to the next category.

The next category, Category IV B, is when other antibiotic options are available that are equally effective but less toxic or safer. The evaluation results show no recorded side effects or toxicity of the antibiotic given in the patient's medical record, indicating there are no safer options than the given antibiotic. Therefore, the assessment proceeds to the next category.

The next category, category IV C, involves the availability of antibiotics with comparable effectiveness but lower costs. Assessment in this category is based on comparing the prices of the antibiotics used in therapy. In general, generic antibiotics are less expensive than brand-name antibiotics. (Anggraini et al., 2020) The evaluation results indicated that the antibiotics used in this study were generic antibiotics that met the indications and therapeutic guidelines and were cost-effective. Therefore, the assessment proceeded to the next category.

The next category, category IV D, involves the use of antibiotics of equal effectiveness but with a narrower spectrum. The evaluation results showed no first- or second-line antibiotics with a narrower spectrum because the antibiotics administered were broad-spectrum. Therefore, the assessment continued to the next category.

Categories III A and III B include antibiotics that are discontinued. These categories indicate that the duration of antibiotic therapy was either too long or too short. The duration of antibiotic therapy is a crucial aspect of infection management because it significantly impacts the success of therapy. In clinical practice, the duration of antibiotic therapy is determined by the patient's clinical condition, the type of microorganism causing the infection, and the patient's response to treatment.

Inappropriate durations include administering antibiotics for too short a time, resulting in suboptimal therapy, or administering them for too long without clear indications, which can increase the risk of resistance, making infection management more difficult. Therefore, in cases of urinary tract infections, antibiotics must be administered appropriately to minimize the risk of antibiotic resistance. (Paluseri et al., 2022).

Several studies evaluating the rationality of antibiotic use using the Gyssens method have shown that inappropriate antibiotic therapy durations are still common in clinical practice. In a study at Dr. H. Abdul Moeloek Regional Hospital, 7.3% of antibiotic regimens were classified as too long (IIIa) and 1.6% as too short (IIIb) according to the Gyssens algorithm. (Purnamasari et al., 2025)

According to the Gyssens chart, category IIA indicates inappropriate antibiotic dosage, and some antibiotics are discontinued in this category. Accurate dosing plays a crucial role in determining the success of antibiotic therapy. The dose administered must achieve drug levels in the blood or tissue sufficient to kill or inhibit the growth of the bacteria causing the infection. If the dose is too low, the drug concentration may not reach the required therapeutic level. As a result, the bacteria are not fully eradicated, resulting in a prolonged infection, a risk of recurrence, and even the development of antibiotic resistance. (Paluseri et al., 2022) Conversely, administering doses exceeding therapeutic requirements is not without risks. Doses that are too high can increase the likelihood of side effects. Certain antibiotics are known to have the potential for quite serious side effects when used in excessive doses or without adjustment, such as impaired kidney function, hearing loss (ototoxicity), and fluid and electrolyte imbalances. Therefore, dose adjustment based on the patient's weight, age, kidney function, and clinical condition is crucial in clinical practice. (Oktaviani et al., 2025; Selifiana et al., 2023).

The next category is category IIB, which refers to inappropriate dosing intervals. Evaluation results indicate that the dosing intervals or frequencies are within guidelines: first-line ciprofloxacin is administered to patients with pyelonephritis every 12 hours, or twice daily, and second-line ceftriaxone is administered every 24 hours, or once daily.

The next category is category II C, which refers to an inappropriate route of administration. The evaluation results showed that the route of administration was in accordance with guidelines, with antibiotics administered intravenously to hospitalized pyelonephritis patients in this study. The intravenous route was chosen because the patient's condition required therapy with a rapid onset of action and to ensure adequate drug levels were achieved in the blood.(Maharani et al., 2019).

The next category is Category I, which refers to inappropriate administration. Antibiotic use is considered inappropriate if it is not administered at the correct time each day. The evaluation results showed that all doses were administered at the correct interval, thus ensuring appropriate administration.

The final category analyzed was category 0. This category indicates rational antibiotic use. The assessment of antibiotic use appropriateness was conducted by considering appropriate indications, drug selection based on effectiveness, toxicity, cost, and spectrum of action, as well as the appropriate dosage, interval, duration, time of administration, and route of administration.

Based on the evaluation results, a total of 23 antibiotic uses were categorized as appropriate and rational. This was because the antibiotic therapy administered met the appropriateness criteria, including appropriate dosage, administration interval, duration of antibiotic administration, and antibiotic selection in accordance with applicable treatment guidelines. However, several inconsistencies were still found in antibiotic use, including administration of antibiotics for too short or too long, and administration of antibiotics at incorrect dosages.

Antibiotic use varies across hospitals, resulting from differing antibiotic management and control policies, resistance patterns of bacteria causing urinary tract infections in each healthcare facility, and differences in patient characteristics, including disease severity and comorbidities. Therefore, monitoring antibiotic use is necessary to support programs to control the risk of antibiotic resistance and increase antibiotic use in healthcare settings.(Ministry of Health Regulation, 2021).

ATC/DDD Evaluation

The ATC/DDD method was used to determine the most dominant antibiotic consumption patterns given to inpatients with Urinary Tract Infections (UTIs) at Dr. Moewardi Surakarta Regional General Hospital during the period of January-June 2025. This evaluation displays the results of processing antibiotic use data based on the ATC/DDD method, which contains the route of administration, ATC code, DDD value (grams) according to WHO standards, and the calculation of DDD per 100 days of hospitalization in patients with urinary tract infections. All data is presented in the form of an ATC/DDD table.

Based on the 2021 Minister of Health Regulation concerning Guidelines for Antibiotic Use, ciprofloxacin is classified as the first-choice antibiotic for patients with urinary tract infections. Ciprofloxacin has the highest total DDD because it is used by more patients and for a longer duration, but its use intensity is lower per 100 hospital days. Conversely, ceftriaxone has a lower total DDD but a higher use intensity.(WHO, 2025). Thus, the use of total DDD and DDD/100 patient days provides an overview of the pattern and intensity of antibiotic use in hospitalized patients with urinary tract infections.

The Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) method is a quantitative approach recommended by the World Health Organization (WHO) to evaluate the pattern and intensity of antibiotic use in a patient population. In this method, the amount of antibiotic consumption is expressed as the number of DDD per 100 patient-days or per 1000 patient-days, thus allowing comparisons across clinical variations and time periods. A study in the internal medicine ward of Bangil Regional Hospital found that ceftriaxone had the highest DDD/100 patient-days value (27.79), indicating a dominant intensity of use among other antibiotics.(Rachmawati and Dalam, 2020).

The application of the ATC/DDD method in Indonesia confirms that this approach is a valid and frequently used tool to measure the quantity of antibiotic use in retrospective studies.(Apriyanti, 2023).

Antibiotic Rationality with Clinical Outcomes

The results of the analysis using the Fisher Exact test statistically concluded that there was no significant relationship between the rationality of antibiotic use and patient clinical outcomes. This was found in all patients who experienced poor clinical outcomes (13%) in the rational therapy group. Meanwhile, in the irrational therapy group, all patients showed improved outcomes, representing 100% of all cases with improved outcomes.

*Outcome*Clinically, the patient's condition was categorized as improving based on the doctor's medical progress notes from the medical record in the form of improvements in the patient's condition based on parameters referring to the 2024 EAU (European Section of Infection in Urology) guidelines, such as reduced symptoms, stable vital signs, and resolved infection. Meanwhile, the patient was categorized as not improving based on parameters such as fever, painful urination, and unstable vital signs. There were three patients with an increase in temperature, ultimately with a clinical condition where the fever had not subsided, while the remaining patient complained of painful urination and fever.(Bonkat et al., 2024).

Similar results were obtained in a study conducted at Dr. Sardjito General Hospital in Yogyakarta on urinary tract infection (UTI) patients with Extended Spectrum Beta-Lactamase (ESBL), as well as a study at Yogyakarta Hospital on UTI patients receiving empirical and definitive therapy. In both studies, no significant association was found between rational antibiotic use and clinical outcomes, with p-values of 0.381 and 0.106, respectively.(Pratama et al., 2025)However, irrational antibiotic use still requires special attention because it has the potential to increase the risk of antibiotic resistance.

This study has several limitations, including the use of a retrospective design that relies solely on medical record data without direct observation of the patient's clinical condition. This approach makes the researchers highly dependent on the completeness and accuracy of data recorded in the medical record. If any information is incompletely documented, it cannot be analyzed further, potentially impacting the evaluation.

Furthermore, several clinical factors that play a crucial role in determining the success of therapy cannot be comprehensively evaluated. Factors such as the patient's physiological condition, age, disease severity, antibiotic resistance patterns, lack of antibiotic selection, and the presence of chronic diseases cannot be comprehensively analyzed due to limited available data.(Pratama et al., 2025). In fact, these factors have a significant influence on the response to antibiotic therapy and the patient's clinical outcome.

Increasing age is known to be associated with decreased immune system function. This condition makes elderly patients more susceptible to more severe infections and more prone to complications. Furthermore, the elderly are also more likely to have chronic illnesses such as diabetes mellitus, kidney disease, or cardiovascular disorders, which can exacerbate infections and hinder the effectiveness of antibiotic therapy. The presence of these comorbidities often requires more complex therapy adjustments.(Mano et al., 2023)

The decline in physiological function in old age also affects drug pharmacokinetics, including absorption, distribution, metabolism, and elimination. Disruptions in drug absorption can prevent blood drug levels from reaching optimal therapeutic concentrations, thus reducing treatment effectiveness. Furthermore, changes in kidney and liver function can also slow drug elimination, potentially increasing the risk of side effects if dosage adjustments are not appropriate.(Pratama et al., 2025).

Given these limitations, the results of this study should be interpreted with caution. Nevertheless, the findings provide insight into antibiotic use patterns and can serve as a basis for further prospective studies to allow for more in-depth clinical evaluation.(Pratama et al., 2025).

CONCLUSION

This study found that of 50 adult inpatients with acute pyelonephritis at Dr. Moewardi Regional General Hospital, 64% were female and 52% were over 60 years old, with ciprofloxacin dominating antibiotic use (90%) followed by ceftriaxone (10%). Rationality based on the Gyssens method reached 46% (category 0), while 54% were irrational mainly due to too short duration (44%, category IIIB), too long (8%, IIIA), and inappropriate dosage (2%, IIA); ATC/DDD analysis showed that ciprofloxacin (J01MA02) contributed 47.2% of DDD/100 patient days and ceftriaxone 52.8%. Clinical outcomes improved in 94% of patients, but Fisher's Exact test ($p=0.090$) did not show a significant association between antibiotic rationality and outcome. The limitations of the retrospective design depend on the completeness of medical records, so factors such as comorbidities, bacterial resistance patterns, and renal function in the elderly were not thoroughly evaluated, potentially influencing the interpretation of the results. Suggestions for future research include prospective designs with urine culture testing and antibiotic stewardship monitoring, as well as practical implications such as clinician training to optimize duration and dosage according to Minister of Health Regulation No. 28/2021 to prevent resistance, especially in elderly female patients.

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