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The Relationship Of Antibiotic Rationality To Clinical Outcomes In Adult UTI Patients Using The Gyssens Method At The Inpatient Unit Of PKU Muhammadiyah Hospital, Surakarta

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Abstract

Urinary Tract Infection (UTI) is a common infection with a high risk of antibiotic resistance due to irrational use. This study evaluated the rationality of antibiotics on the clinical outcomes of adult UTI patients using the Gyssens method at PKU Muhammadiyah Surakarta Hospital. To analyze the profile, rationality of antibiotics, and their relationship with clinical improvement. Retrospective descriptive study on 77 adult UTI inpatients from January to December 2024, purposive sampling, medical record instruments, Gyssens and Chi-Square analysis (SPSS 25). Rationality 53.25% (category 0), Cefuroxime most (38.96%), normal leukocytes 92.2%, p = 0.006 indicating a significant relationship between rationality and clinical improvement. Rational use of antibiotics significantly improves the clinical outcomes of UTI, supporting antimicrobial stewardship.

Keywords: Antibiotics, Gyssens Method, Rationality, Urinary Tract Infection.

INTRODUCTION

Urinary Tract Infections (UTIs) are one of the most common infections in healthcare settings, both in the community and in hospitals, with a global incidence reaching millions of cases annually according to the World Health Organization. In Indonesia, the prevalence of UTIs is estimated at 90-100 cases per 100,000 people per year, or around 180,000 new cases, with an increased risk in adult patients due to factors such as advanced age, diabetes, and catheterization.

The use of antibiotics as the primary therapy for UTIs is effective in eradicating bacteria, but it is often irrational, leading to complications such as pyelonephritis and sepsis. [Indonesian Ministry of Health, 2023] This high prevalence is also associated with risk factors such as female gender and a history of previous UTIs, which increase the cost of hospital care.

Irrational antibiotic use in UTI patients often includes inappropriate dosage, duration, and drug selection, which contributes to antimicrobial resistance (AMR) with Extended Spectrum Beta-Lactamase (ESBL) rates reaching 70.75% in E. coli and Klebsiella pneumoniae in Indonesian hospitals. Research shows that antibiotic rationality using the Gyssens method is only 53-58% in similar cases, leading to treatment failure, relapse, and increased mortality.

This problem is exacerbated by nosocomial bacterial patterns such as resistant Pseudomonas aeruginosa, especially in hospitalized patients with indwelling catheters, thus requiring rigorous evaluation to reduce morbidity and healthcare costs. [Zakirah et al., 2025] Mismatched indications and drug spectrum also increase toxicity and length of hospital stay, as found in a study of Indonesian hospitals. [Wirda et al., 2020]

This study aims to evaluate the profile and rationality of antibiotic use on clinical outcomes of adult UTI patients in the Inpatient Unit of PKU Muhammadiyah Hospital Surakarta using the Gyssens method, and analyze its relationship with symptom and laboratory improvement. The urgency of this study arises from the high AMR and low antibiotic rationality in local hospitals, which can shorten hospitalizations and save costs according to the Indonesian Ministry of Health (2023). The novelty lies in the specific application of Gyssens for adult UTI patients in this hospital, which has never been studied before, different from pneumonia or outpatient studies. [Sukmawati et al., 2020].

RESEARCH METHODS

Types and Methods of Research

This study used a non-experimental descriptive design with a retrospective approach to describe the relationship between the rationality of antibiotic use and the clinical outcomes of adult UTI patients using the Gyssens method at the Inpatient Unit of PKU Muhammadiyah Surakarta Hospital during the period January-December 2024. The retrospective descriptive approach allows for the review of historical data from medical records without intervention, in accordance with Sugiyono (2021) who emphasized this design to analyze health phenomena objectively through secondary data. The Gyssens method was applied for qualitative evaluation of rationality based on indications, doses, routes, durations, and times of administration, as recommended in similar studies to identify therapeutic discrepancies.

Data Analysis Instruments and Techniques

The primary research instrument was the medical records of adult UTI patients who met the inclusion criteria, including UTI diagnosis, antibiotic administration, and clinical outcome data such as improvement in dysuria symptoms and laboratory results. Data were extracted using a structured observation sheet to ensure validity and reliability, in accordance with Creswell and Creswell's (2023) guidelines for secondary instruments in a retrospective mixed methods design. Data were analyzed descriptively using Microsoft Excel for the frequency and percentage of antibiotic profiles, and the Chi-Square test in SPSS version 25 to examine the relationship between rationality (Gyssens categories 0-VI) and clinical outcomes, with a significance level of $p<0.05$ as described by Emzir (2021) in a descriptive quantitative analysis [Irmawatini, 2017].

Population and Sample

The study population included all adult patients (aged ≥18 years) diagnosed with UTI and receiving antibiotic therapy at the Inpatient Unit of PKU Muhammadiyah Surakarta Hospital during January-December 2024. Samples were taken using a purposive sampling technique based on inclusion criteria such as complete record data and exclusion of immunocompromised or transferred patients, resulting in a representative sample of at least 77 cases according to the Slovin formula [Sugiyono, 2021]. This technique is in accordance with Sudaryono (2021) for retrospective health studies to ensure homogeneity and reduce selection bias in limited populations.

Research Procedures

The procedure began with a proposal submission, ethical clearance, and data release permit from PKU Muhammadiyah Surakarta Hospital, followed by a manual search of medical records to summarize the data according to the criteria. The data were then verified, categorized for rationality using Gyssens, and statistically analyzed using SPSS to test for correlations, as is the systematic flow in clinical pharmacy research [Zakirah et al., 2025]. The entire process adhered to research ethics with patient anonymity, in line with Creswell's (2023) guidelines on ethical and replicable retrospective procedures [Sukmawati et al., 2020].

RESULTS AND DISCUSSION

Patient Characteristics

Table 1. Patient Characteristics

Characteristics	Number of Patients (n)	Percentage (%)
Gender		
Man	22	28.6
Woman	55	71.4
Age (years)		
18–59	77	100
Treatment Duration (days)		
3 – 7	69	89.6
> 7	**8**	**10.4**

The results in Table 1 show that of the 77 patients analyzed, 28.6% were male and 71.4% were female, aged 18-59. Of the total patients, 89.6% had a length of stay of 3-7 days, and 10.4% had a length of stay of more than 76 days.

Use of Antibiotic Therapy in UTI Patients

The following table shows the distribution of antibiotics used in UTI patients treated at PKU Muhammadiyah Surakarta Hospital.

Table1. Use of UTI Antibiotic Therapy

Antibiotic Name	Number of Patients (n)	Percentage (%)
Anbacim 1 gram injection (Cefuroxime)	30	38.96
Cefoperazone sulbactam 1 gram injection	12	15.58
Levofloxacin 500 mg infusion	6	7.79
Ampicillin sulbactam 1500 injection	6	7.79
Levofloxacin 750 mg infusion	5	6.49
Cerfoperazone 1 gram injection	4	5.19
Ciprofloxacin 200 mg infusion	4	5.19
Cefotaxime 1 gram injection	3	3.90
Meropenem 1 gram injection	3	3.90
Ceftriaxone 1 gram injection	2	2.60
Amikacin 500 mg injection	1	1.30
Pelastin 1 gram injection (Cilastin, Imipenem)	1	1.30
Total	**77**	**100**

The results of the study in table 2 show that from a total of 77 patients analyzed, there was the use of antibiotic therapy anbacim 1 gram 38.96%; cefoperazone sulbactam 1 gram 15.58%; levofloxacin 500 mg 7.79%; ampicillin sulbactam 1500 mg 7.79%; levofloxacin 750 mg 6.49%; cefoperazone 1 gram 5.19%; ciprofloxacin 200 mg 5.19%; cefotaxime 1 gram 3.90%; meropenem 1 gram 3.90%; ceftriaxone 1 gram 2.60%; amikacin 500 mg 1.30%; pelastin 1 gram 1.30%.

Antibiotic Rationale Based on Gyssens Category

Table 3. Analysis of Antibiotic Rationality based on Gyssens Category

Category	Information	Number (n)	Percentage (%)
0	Correct indication, drug, dose, interval, route, duration	41	53.25
I	Incorrect timing of administration	3	3.90
II A	Incorrect dosage	12	15.58
II B	Incorrect interval	8	10.39
II C	Incorrect route	0	0
III A	Duration is too long	7	9.09

Category	Information	Number (n)	Percentage (%)
III B	Duration is too short	4	5.19
IV A	There are more effective alternatives	2	2.60
IV B	Safer antibiotics	0	0
IV C	Cheaper antibiotics	0	0
IV D	Narrower spectrum antibiotics	0	0
V	There is no indication	0	0
VI	Data cannot be evaluated	0	0
Total		**77**	**100**

The results of the study in Table 3 show that the rational use of antibiotics with category 0 was 53.25% and irrational with categories I-IV A with 46.75%.

Patient's Clinical Condition after Hospitalization

Table 2. Patient's Clinical Condition after Hospitalization

Clinical Conditions	Number of Patients (n)	Percentage (%)
Leukocytes in urine (cells/LPB)		
4-5	56	72.72
5-10	15	19.48
10-20	6	7.80
Body Temperature (0C)		
36-37	**77**	**100**

The results of the study in table 4 show that normal leukocytes in 1-10 cells/LPB were 92.20% and abnormal leukocytes in 10-20 cells/LPB were 7.80% with normal body temperature in the range of 36-370C throughout.

The Relationship Between Antibiotic Rationality and Therapeutic Success

Table 5. Relationship between Antibiotic Rationality and Therapy Success

Rationality	Therapy Success		Total
	Getting better	Not Getting Better	
Rational	41	0	41
Irrational	30	6	36
Total	**71**	**6**	**77 (100%)**

The results of the study in Table 5 show that all rational antibiotics also showed clinical improvement and of the 36 irrational antibiotics, 30 patients showed clinical improvement and 6 patients showed no clinical improvement.

Data Analysis using Chi-Square Test

The following are the results of the Chi-Square test:

Table 3. Chi-Square Test Results

Rationality	Therapy Success		Total	*Sig.*
	Getting better	Not Getting Better		
Rational	41	0	41	0.006
Irrational	30	6	36	
Total	**71**	**6**	**77 (100%)**	

The research results in table 6 show the significance of the Chi-Square test of 0.006, where this value is smaller than 0.05 ($p < 0.05$).

DISCUSSION

Patient Characteristics

The results of this study showed that of the 77 patients analyzed, 28.6% were male and 71.4% were female. The higher proportion of female patients indicates a natural predisposition to UTIs, with women being more susceptible to urinary tract infections than men. This finding aligns with widely published research, including a study by Medina and Castillo-Pino (2019), which identified that women experience UTIs more frequently due to anatomical and hormonal differences. In women, the shorter urethra allows bacteria to enter the bladder, increasing the likelihood of infection. This study found that estrogen levels, which protect the female urinary tract, may decrease during pregnancy or menopause, increasing susceptibility to UTIs.

Research by Rowe and Juthani-Mehta (2013) also supports the idea that women, particularly older adults, are at higher risk for UTIs due to decreased immune function and changes in body anatomy that favor infection. Although the majority of patients in this study were women, particularly those aged 18–59, this reflects the general finding that adult women are more likely to develop UTIs than men, particularly due to these factors.

Patient age is closely related to length of stay, with patients over 59 years of age tending to require longer hospitalizations, typically more than 7 days. This is consistent with existing literature findings showing that elderly patients are at higher risk for UTI complications, such as pyelonephritis or urosepsis, which require more aggressive antibiotic therapy and longer treatment durations. A weakened immune system and the presence of comorbidities in elderly patients often exacerbate infections, prolonging treatment and recovery. The study found that length of stay for UTI patients was divided into two main groups: 3–7 days (89.6%) and more than 7 days (10.4%). Most UTI patients in this hospital were treated for 3–7 days, indicating that the UTIs they encountered tended to be uncomplicated or mildly complicated, and therefore could be managed with shorter treatment durations. This aligns with guidelines recommending a 3–5-day treatment duration for uncomplicated UTIs in young adults and is consistent with research by Gupta et al. (2018) regarding length of stay.

Although the majority of patients in this study were aged 18 to 59 years and received appropriate treatment duration, some patients required longer treatment, exceeding 7 days. This may have been due to complications of UTIs or other medical conditions that exacerbated the infection. This finding is also consistent with research by Hooton et al. (2014), which suggests longer treatment durations for patients with more severe conditions, such as urinary tract infections uncontrolled with initial empiric antibiotics.

Uncomplicated UTIs tend to be treatable with oral antibiotics in a shorter course, typically 3-5 days. However, complicated UTIs such as pyelonephritis or urosepsis require parenteral antibiotic therapy and a longer course, typically more than 7 days, as noted in this study. In this case, the failure of initial therapy or more severe infectious complications are contributing factors to the length of treatment. Furthermore, patients with kidney impairment may also experience a longer treatment duration because impaired kidney function affects antibiotic elimination. Decreased kidney function can result in longer treatment times and adjusted dosages (Nicolle, 2015).

Use of Antibiotic Therapy in UTI Patients

Appropriate antibiotic use is a crucial part of managing Urinary Tract Infections (UTIs) to ensure patient recovery and prevent the emergence of antibiotic resistance. Successful UTI treatment depends heavily on the selection of appropriate antibiotics for the pathogen causing the infection, as well as the patient's clinical condition, including age, gender, immune status, and comorbidities. This study aimed to evaluate the rationality of antibiotic use in UTI patients at PKU Muhammadiyah Hospital, Surakarta, and to determine the extent to which the therapy complied with existing guidelines.

Antibiotic use is the primary therapy in the management of urinary tract infections (UTIs). Successful therapy is greatly influenced by the appropriate antibiotic selection based on the causative bacterial pattern, the severity of the infection, the patient's clinical condition, and local resistance patterns. Globally, Escherichia coli is reported to be the leading cause of UTIs, both in uncomplicated and complicated cases, followed by Klebsiella pneumoniae, Proteus mirabilis, and Enterococcus spp. (Flores-Mireles et al., 2015).

The antibiotic therapy guidelines for UTI patients in this study refer to the National Clinical Service Guidelines (PNPK), the 2025 UTI Management Guidelines of the Indonesian Ministry of Health and the 2015 UNAIR UTI Management Guidelines. The choice of antibiotics should consider the clinical syndrome (cystitis/pyelonephritis/complicated UTI), patient condition (comorbidities, renal function, oral tolerance), as well as local resistance patterns and antibiotic sensitivity tests (Indonesian Ministry of Health, 2025).

Cystitis (including special conditions such as pregnancy). The National Center for Disease Control and Prevention (PNPK) states that treatment of cystitis in pregnant women is carried out with antibiotics for 5-7 days and does not recommend a 3-day therapy. If starting empiric therapy before culture, amoxicillin or ampicillin regimens are recommended to be avoided due to increasing E. coli resistance. The PNPK also states that single-dose fosfomycin can provide similar clinical results compared to other regimens and can improve compliance, but nitrofurantoin and fosfomycin should be avoided if pyelonephritis is suspected because they do not reach adequate renal tissue levels (Ministry of Health of the Republic of Indonesia, 2025). The UNAIR guidelines emphasize antibiotic selection guided by local resistance patterns and sensitivity testing, and the duration of therapy depends on the drug used, ranging from 1-7 days in certain contexts (Seputra et al., 2015).

Acute pyelonephritis requiring hospitalization. The National Patient Safety Guidelines (PNPK) state that in acute pyelonephritis, patients can be hospitalized to maintain hydration and receive parenteral antibiotic therapy for at least 48 hours, and re-evaluation is necessary if the clinical response is poor after 48-72 hours. For patients requiring hospitalization, the PNPK includes several IV therapy options, including ciprofloxacin 400 mg every 12 hours (7 days), levofloxacin 750 mg once daily (5 days), ceftriaxone 1-2 g once daily, cefotaxime 1 g every 8 hours, and meropenem 500 mg every 6 hours. The PNPK also emphasizes the strategy of administering injectable drugs followed by oral therapy after gastrointestinal symptoms resolve or the patient can tolerate oral therapy (Ministry of Health of the Republic of Indonesia, 2025).

Complicated UTI and the principle of culture-de-escalation, UNAIR Guideline explains that empirical therapy of complicated UTI requires knowledge of the pathogen and local resistance patterns, evaluation of renal function, and urine culture should be performed before antimicrobial therapy is initiated and empirical therapy should be changed according to urine culture results. It also states that the duration of antibiotics of 7-14 days is generally recommended for complicated UTI, and in certain clinical situations can be extended. This principle is in line with stewardship: avoiding prolonged empirical antibiotics because it can encourage resistance (Seputra et al., 2015).

Based on the results of this study, the most commonly used antibiotics were anbacim injection (38.96%) and cefoperazone sulbactam injection (15.58%), followed by fluoroquinolones such as levofloxacin and ciprofloxacin. The dominance of broad-spectrum parenteral antibiotics indicates that most patients had moderate to severe UTIs or complicated UTIs requiring inpatient care. Beta-lactam antibiotics, including cephalosporins and combinations of beta-lactams with beta-lactamase inhibitors, are frequently used therapies in hospitalized UTI patients. The use of cefoperazone sulbactam and ampicillin sulbactam in this study is in accordance with Guideline recommendations stating that antibiotics combined with beta-lactamase inhibitors are effective in treating beta-lactamase-producing bacteria in complicated UTIs (Gupta et al., 2018). A study by Tandogdu and Wagenlehner (2016) found that increasing E. coli resistance to ampicillin and trimethoprim-sulfamethoxazole has prompted the use of third-generation cephalosporins and combination antibiotics as empiric therapy in hospitals. This finding aligns with the findings of this study, which showed high use of broad-spectrum beta-lactam antibiotics.

Fluoroquinolone antibiotics, such as levofloxacin and ciprofloxacin, are used in approximately 19.47% of patients. Fluoroquinolones have good tissue penetration and are effective for upper urinary tract infections (UTIs), including pyelonephritis. However, several recent guidelines recommend limiting the use of fluoroquinolones due to increasing resistance rates and the risk of serious side effects. Fluoroquinolone resistance in E. coli has increased significantly in various countries, so these antibiotics should be used selectively and based on culture results whenever possible (Grigoryan et al., 2018).

Antibiotics such as meropenem (3.90%) and amikacin (1.30%) are used in small amounts. Carbapenems are recommended for cases of severe complicated UTIs or suspected infection by ESBL (Extended Spectrum Beta-Lactamase)-producing bacteria (Nicolle, 2019). The limited use of meropenem in this study suggests that last-line antibiotics are still used relatively selectively. Aminoglycosides such as amikacin are effective against gram-negative bacteria, but their use is limited due to potential nephrotoxicity, particularly in patients with renal impairment or the elderly (Flores-Mireles et al., 2015). This may explain the low percentage of amikacin use in this study.

The distribution of antibiotics in this study indicates that antibiotic selection generally followed the principles of inpatient UTI therapy. However, the high proportion of broad-spectrum antibiotics underscores the importance of antimicrobial stewardship programs to ensure rational antibiotic use, particularly regarding dosage, interval, and duration of therapy. A study by Nicolle (2019) emphasized that uncontrolled use of broad-spectrum antibiotics can accelerate the development of resistance and increase patient length of stay.

Antibiotic Rationale Based on Gyssens Category

Conceptually, the Gyssens method assesses the quality of antibiotic prescribing based on the accuracy of drug selection and administration (dose, interval, route, duration, and time of administration). Therefore, the distribution of categories in this study can be used to identify priority areas for improvement in antimicrobial resistance control programs.

Implications for the Gyssens assessment, PNPK, and several guidelines that form the basis for rationality assessments: inappropriate dosage/interval/duration will fall into categories II-III, while antibiotic selection that is inconsistent with the primary choice for a specific clinical syndrome may fall into category IV. Therefore, recording the diagnosis of UTI syndrome, renal function, and culture/antibiogram data is key to making the Gyssens assessment more accurate and actionable in the PPRA program.

The Gyssens method is used to evaluate the rationality of antibiotic use based on criteria such as indication, effectiveness, safety, dose, interval, route of administration, duration, and time of administration. The categories used in this method include 0 (appropriate), I-VI (irrational), with analysis based on applicable clinical guidelines and available microbiological data. The evaluation is based on the patient's medical records and clinical condition.

In this study, category 0 (overall appropriateness) reached 53.25%. In this category, all aspects of antibiotic therapy were implemented appropriately and rationally. The antibiotic selected was appropriate for the type of pathogen causing the infection, the dosage and interval of administration were appropriate, and the duration of treatment was sufficient to resolve the infection. This finding aligns closely with various studies in Indonesia showing that a category 0 assessment reflects clinically appropriate antibiotic use.

Category I (3.90%) indicates inappropriate timing of antibiotic administration. Inappropriate timing can occur if antibiotics are administered too long after diagnosis or if antibiotic therapy is not initiated immediately after infection is identified. Delaying antibiotic administration can worsen the patient's condition and lead to more serious complications. Timeliness of administration is crucial to ensure optimal drug exposure, especially in infections with systemic manifestations (Nicolle, 2019). Within the Gyssens framework, inappropriate timing of administration is classified as irrational because it can impact the effectiveness of therapy.

Categories IIA (15.58%) and IIB (10.39%) were the largest sources of irrationality in this study. Dose and interval are key determinants of achieving antibiotic pharmacokinetic and pharmacodynamic targets. Errors in these aspects can lead to subtherapeutic exposure, which risks therapy failure and selection of resistance, or overexposure, which increases toxicity and costs. In the adult UTI study, the proportion of irrationality in IIA (6.6%) and IIB (4.6%) was lower than the findings in Nabila et al.'s (2024) study. National guidelines emphasize that optimizing antimicrobial therapy takes into account clinical conditions, causative microorganisms, sensitivity results, and patient factors such as renal function (Ministry of Health of the Republic of Indonesia, 2025). Therefore, the findings in IIA and IIB indicate the need to strengthen dose and interval standardization, including adjustments for patients with impaired renal function or certain clinical conditions.

Inappropriate therapy durations were still found in this study, with IIIA (too long duration) occurring at 9.09% and IIIB (too short duration) occurring at 5.19%. Excessively long durations increase the risk of side effects, costs, and resistance selection pressure; while excessively short durations increase the risk of recurrence and failure to eradicate the infection. Duration evaluation is a crucial component of Gyssens (Hidaya et al., 2025). In complicated UTIs, guidelines recommend culture sampling before antimicrobial administration and the use of microbiological characteristics to optimize therapy. If clinical and microbiological evaluations are not utilized or documented properly, therapy is at risk of being continued longer than necessary or discontinued too early.

The IVA category in this study was relatively low (2.60%). This figure is lower than a study of adult UTIs, which reported an IVA of 17.8% with empiric antibiotics. A low IVA may indicate that antibiotic selection is relatively in line with the reference standards used, and that irrationality is more prevalent in aspects of dosage, interval, duration, or timing of administration (Nabila et al., 2024).

However, empirical antibiotic selection should ideally consider local bacterial patterns and susceptibility. Local guidelines report the presence of antibiotics with low sensitivity in certain data, so empirical selection should be adjusted to the local antibiogram (Seputra et al., 2015). Therefore, low VIA results should still be interpreted in conjunction with local resistance data to ensure effective empirical decisions.

The absence of categories IIC, IVB, IVC, IVD, and VI may indicate that the recorded route of administration was appropriate and that the antibiotic indication was present in the analyzed data. However, the absence of categories V and VI also significantly impacts the completeness of documentation. Therefore, improving the quality of recording indications and rationales for therapy remains necessary to maintain accurate evaluations and continuity of care.

Patient's Clinical Condition after Hospitalization

Leukocyte counts and body temperature are closely linked in assessing the success of UTI treatment. Both are important indicators that help doctors determine whether antibiotic therapy is effective in treating the existing infection. A decrease in leukocyte counts and body temperature are two parameters that support each other in assessing treatment success.

Leukocytes are a key indicator in detecting infection. In this study, 56 patients (72.7%) had leukocyte counts of 4-5 cells/LPB, indicating an ongoing immune response to infection. Meanwhile, 15 (19.5%) and 6 (7.8%) patients had leukocyte counts of 5-10 cells/LPB, indicating a more significant increase in the body's immune response. A decrease in leukocyte counts after hospitalization indicates effective treatment. Returning to near-normal values indicates that the infection has been controlled and the therapy is working effectively. These findings align with literature that suggests a decrease in leukocytes is associated with reduced infection or inflammation due to appropriate treatment (Ministry of Health of the Republic of Indonesia, 2025).

Body temperature is also an important indicator for assessing the success of UTI treatment. The study showed that all patients had a body temperature between 36°C and 37°C after hospitalization. A stable and normal body temperature indicates that the infection is resolving and the patient's body has responded well to treatment. A decrease in body temperature following antibiotic administration is an important clinical sign for determining the effectiveness of antibiotic therapy. This is in line with treatment guidelines, which indicate that fever reduction is a key parameter in evaluating the success of UTI treatment (Seputra et al., 2015).

Clinically, the presence of leukocytes in the urine (pyuria) indicates local inflammation in the urinary tract due to infection. When the bacteria are successfully suppressed by antibiotics and the inflammatory response subsides, the number of leukocytes in the urine tends to decrease toward normal values. Therefore, a decrease in urinary leukocytes can be understood as a sign of a reduction in the local infection burden and inflammation. Meanwhile, body temperature (fever) is more indicative of the systemic inflammatory response. In UTIs (especially when more severe), fever occurs due to the release of inflammatory mediators in the body's response to infection. When therapy is effective, the systemic inflammatory process will decrease, resulting in a return to normal body temperature. A normal temperature indicates general clinical improvement and a reduction in the systemic inflammatory response, while a decrease in leukocytes indicates improvement at the site of infection (Mansfield et al., 2022).

The Relationship between the Rationality of Antibiotic Use and the Success of Therapy Based on the Patient's Clinical Condition

Rational antibiotic use means administering the appropriate medication according to clinical indications, taking into account the spectrum of causative bacteria, the timing of administration, and the duration according to standard guidelines. Irrational antibiotic administration, such as using a broad spectrum antibiotic without culture evidence, doses that are too high or too low, or durations that are too long or too short, not only reduces the effectiveness of therapy but also increases the risk of antibiotic resistance.

The study results showed that some patients received rational therapy; those receiving rational therapy showed greater clinical improvement, indicated by a decrease in urinary leukocytes and normalization of body temperature after hospitalization. This is in line with recommended clinical practice, which states that appropriate antibiotic use will help quickly resolve infections and reduce the bacterial load in the urinary tract, resulting in clinical improvement in patients (Nabila et al., 2024).

Six patients (0.8%) were assessed as not improving with irrational medication use. This was indicated by urine leukocyte counts that did not exceed the normal limit of 10-20 cells/μL. Clinical symptoms were considered to be improving if the urine leukocyte count was in the range of 4,500–11,000 cells/μL, and were considered not improving if the urine leukocyte count was <4,500 cells/μL or >11,000 cells/μL (Hidaya et al., 2025).

Studies evaluating the rationality of antibiotic prescribing in patients with UTIs have found that adherence to guidelines improves clinical outcomes, while inappropriate practices have the opposite effect. For example, a study in Indonesia showed that approximately 54.9% of antibiotic prescriptions for patients with UTIs were rational based on the Gyssens method, while the remainder were inappropriate and potentially worsened clinical outcomes (Global Health Science Group, 2024).

In addition, reports from broader studies state that a lot of overprescribing or giving antibiotics that are not according to indications, especially for asymptomatic cases or incorrect diagnoses, can result in increasing resistance rates and reduce the effectiveness of available antibiotics (PMC, 2015). Inappropriate use of antibiotics in research occurs in several cases:

Antibiotic Selection

Broad-spectrum antibiotics without culture evidence can exert selective pressure on the bacterial flora and stimulate resistance, making therapy less effective if the target bacteria are protective against the spectrum of the drug.

Dosage and Duration of Drug Use

Too long a duration of therapy can increase selection for resistance and damage the normal flora, while too short a duration can leave lingering bacteria that can trigger relapse. Another study showed that many patients received longer-than-guided therapy durations, which was also associated with increased side effects and resistance (Tansarli et al., 2022).

Sensitivity and Culture Tests

Inaccuracies often occur when therapy is initiated without urine culture or sensitivity results, resulting in antibiotics that are sometimes ineffective against the causative bacteria. This can lead to clinical failure, exacerbated by bacterial resistance.

Clinically, patients receiving irrational therapy tend to be less responsive: fevers persist longer, leukocyte counts do not decrease significantly, and the risk of complications increases. The global rise in multidrug-resistant organisms (MDROs) resistance also poses a real threat, highlighting the importance of antibiotic stewardship (the systematic management of antibiotic use) in all clinical settings, including inpatient and outpatient settings (Smith et al., 2021).

The concept of antibiotic stewardship encompasses a series of strategies to ensure the appropriate use of antibiotics with the goal of maximizing clinical outcomes, minimizing resistance, and suppressing side effects. International studies confirm that effective stewardship programs can optimize antibiotic use in patients with UTIs and directly link rational practices to improved clinical outcomes (Faruqi et al., 2020). Examples of stewardship strategies include:

a. Accurate diagnosis to differentiate true infection from asymptomatic bacteriuria so that antibiotics are administered only when absolutely necessary.
b. Therapy adjustments are based on urine culture and sensitivity test results.
c. Use the duration of therapy according to guidelines (e.g. 3–7 days of therapy for uncomplicated urinary tract infections, depending on severity).

Implementation of these strategies has been shown to improve patient clinical outcomes, reduce fever duration, decrease relapse rates, and accelerate the decline in biomarkers of infection such as leukocytes, which is also reflected in the results of this study.

Data Analysis using Chi-Square Test

Test*Chi-Square*used to test the relationship or association between two categorical variables. In this study, the Chi-Square test can be used to test whether there is a significant relationship between the rationality of antibiotic use and the success of therapy in UTI patients. The chi-square test is a statistical test used to determine whether there is a relationship between two categorical variables, namely antibiotic rationality and clinical outcomes. In this study, the chi-square test was conducted by entering the results of antibiotic rationality data in UTI therapy in adult inpatients at PKU Muhammadiyah Surakarta Hospital, which had been categorized based on the Gyssens method, with clinical conditions after the hospitalization period.

Based on Table 4.6, the statistical analysis in this study was conducted using the SPSS version 25 program with a chi-square correlation test at a significance level of 0.05 to determine the relationship between the rationality of antibiotic use and clinical outcomes in adult patients with urinary tract infections. The results of the analysis showed an Asymp. Sig. (2-sided) value of 0.006 where the value was smaller than 0.05 ($p < 0.05$). Thus, the test decision was that H_0 was rejected and H_a was accepted, so it can be concluded that there is a significant relationship between the rationality of antibiotic use and patient clinical outcomes. This means that the rational use of antibiotics is directly correlated with the improvement of patient clinical symptoms, such as a decrease in leukocytes and normalization of body temperature.

In this study, patients who received rational antibiotics (in accordance with clinical guidelines and culture results) were more likely to experience clinical improvement. Conversely, patients who received irrational antibiotic therapy, such as inappropriate antibiotic selection or incorrect dosage and duration, were more likely to experience no improvement, with symptoms persisting longer.

CONCLUSION

This study found that of 77 adult UTI patients at the Inpatient Unit of PKU Muhammadiyah Surakarta Hospital, 53.25% of antibiotic use was rational based on the Gyssens method (category 0), while 46.75% was irrational mainly due to inappropriate dosage (15.58%), interval (10.39%), and duration (14.28%). The dominant antibiotics were Cefuroxime (38.96%) and Cefoperazone-Sulbactam (15.58%), with improved clinical outcomes in 92.2% of patients (normal urine leukocytes) and the Chi-Square test showed a significant association (p=0.006) between rationality and clinical improvement. However, limitations of this retrospective study include reliance on complete medical records, potential selection bias from purposive sampling, and lack of complete urine culture data, so the results may not be fully generalizable to other hospitals.

Practical implications include strengthening the Antimicrobial Resistance Control (ADR) program through routine Gyssens audits to optimize dosage and duration, reducing AMR and length of hospital stay. Further research recommendations include prospective studies with urine cultures and stewardship interventions, as well as multi-hospital comparisons to validate local resistance patterns. These findings support the Indonesian Ministry of Health's 2023 national policy of promoting rational antibiotic use to improve outcomes for UTI patients.

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