



Evaluation of the Rationality of Antibiotic Use in Pneumonia Patients Using the Gyssens Method

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Abstract

Pneumonia is one of the leading causes of morbidity and mortality worldwide. The irrational use of antibiotics in pneumonia management can reduce therapeutic effectiveness and increase the risk of antimicrobial resistance. This study aimed to evaluate the rationality of antibiotic use in pneumonia patients at Hospital X using the Gyssens method. This research employed a descriptive observational design with a retrospective approach, utilizing medical record data of adult inpatients diagnosed with pneumonia during the period of January–December 2024. A total of 86 patient records meeting the inclusion criteria were analyzed. Evaluation was conducted using the Gyssens method by comparing the appropriateness of therapy with the Guidelines for the Management of Adult Pneumonia issued by the Indonesian Ministry of Health (Regulation No. 28 of 2021) and the Infectious Diseases Society of America/American Thoracic Society (IDSA/ATS, 2023) guidelines. The results showed that the most frequently used antibiotics were Ceftriaxone (34.88%), Azithromycin (32.56%), and Levofloxacin (32.56%). The most common duration of therapy was five days (53.9%). Based on the Gyssens categories, rational antibiotic use (category 0) was found in 57 cases (66.28%), while the remaining cases were categorized as I (6.98%), IIa (11.63%), IIIa (9.30%), and IIIb (5.81%). These findings indicate that most antibiotic use at Hospital X was rational; however, continuous monitoring and periodic evaluation through the Antimicrobial Resistance Control Program (PPRA) are still necessary to optimize therapeutic effectiveness and prevent antibiotic resistance.

Introduction

Pneumonia is one of the lower respiratory tract infections that remains a leading cause of morbidity and mortality worldwide (Troeger et al., 2017; Feldman & Shaddock, 2019). According to the World Health Organization (WHO, 2023), pneumonia ranks as the fourth leading cause of death globally after ischemic heart disease, stroke, and chronic obstructive pulmonary disease (COPD) with more than 2.5 million deaths annually. This disease affects not only the elderly but also individuals with weakened immune systems and those with comorbidities such as diabetes mellitus, chronic kidney disease, or cardiovascular disorders (Hadiq et al., 2024).

One of the main challenges in pneumonia management is the irrational use of antibiotics, including inappropriate indication, drug selection, dosage, route, and duration of therapy (Mylotte et al., 1994; Abeja et al., 2022; Esposito et al., 2022). Inappropriate antibiotic use can lead to antimicrobial resistance (AMR), which has been recognized as a serious global health

threat. The WHO (2022) estimates that without effective interventions, antibiotic resistance could cause more than 10 million deaths annually by 2050. Furthermore, inappropriate antibiotic use increases treatment costs, prolongs hospital stays, and reduces therapeutic effectiveness (Hou et al., 2023).

In Indonesia, pneumonia remains a major public health concern (Saragih et al., 2022; Lokida et al., 2022; Sutriana et al., 2021; Purba et al., 2019; Azmi et al., 2016). Based on the 2018 Basic Health Research (Riskesdas) report, the national prevalence of pneumonia reached 2.0%, with a higher incidence observed among adults. The use of antibiotics in Indonesian hospitals has also been reported as suboptimal. According to the Antimicrobial Resistance Control Program (PPRA, 2021), approximately 40–50% of antibiotic use in hospitals is irrational, mainly due to inappropriate dosing and treatment duration inconsistent with national guidelines (Sadli et al., 2022; Sibadu et al., 2025; Widiyastuti et al., 2023).

Evaluating the rationality of antibiotic use is an essential component of PPRA implementation in hospitals (Ermawati et al., 2021; Harun et al., 2022; Susanto et al., 2019). One of the internationally recognized methods for assessing antibiotic use is the Gyssens method, which evaluates appropriateness based on six criteria: indication, drug selection, dosage, interval, duration, and the availability of more suitable alternatives (Begum et al., 2014; Dewi et al., 2022; Wori et al., 2025). This method has proven effective in identifying areas for improvement in antibiotic therapy practices across hospitals in Indonesia (Handayani & Yuliana, 2023; Syam & Karuniawati, 2024; Limato et al., 2022; Hadi et al., 2008).

In Southeast Sulawesi Province, pneumonia is among the most common infectious diseases encountered in healthcare facilities. According to data from the Kendari City Health Office (2022), pneumonia cases increased from 1,332 in 2020 to 1,543 in 2021. At Hospital X the main referral hospital in the region the use of antibiotics in pneumonia patients is high; however, a systematic evaluation of its rationality has not yet been conducted (Dinas Kesehatan Kota Kendari, 2022).

Based on these conditions, this study was conducted to evaluate the rationality of antibiotic use in pneumonia patients at Hospital Y and Hospital X using the Gyssens method. The findings are expected to provide an empirical overview of antibiotic use rationality, serve as a foundation for improving the quality of pharmaceutical care services, and strengthen the implementation of the Antimicrobial Resistance Control Program (PPRA) in regional hospitals.

Methods

This study is a descriptive observational research with a retrospective approach, designed to evaluate the rationality of antibiotic use in adult patients with pneumonia who were hospitalized at Hospital X. The descriptive observational design was chosen because it allows a systematic and objective description of antibiotic use patterns that have already occurred, without direct intervention on the study subjects (Notoatmodjo, 2014). The retrospective approach involved tracing and analyzing secondary data obtained from patient medical records, enabling the researchers to assess treatment practices based on clinical guidelines and therapeutic outcomes (Jansen et al., 2005; Scott et al., 2017; Berger et al., 2009; Gundler et al., 2024). The study period covered January to December 2024, with data collection conducted at the Medical Record and Pharmacy Departments of Hospital X. The data collected included patient identity, medical diagnosis, types of antibiotics used, dosage, route of administration, dosing interval, duration of therapy, and clinical outcomes.

Population and Sample

The study population consisted of all adult inpatients (≥ 18 years) diagnosed with pneumonia and receiving antibiotic therapy at Hospital X during January–December 2024. Although the

study population was readily accessible through medical record data, a purposive sampling technique was employed. This approach was selected to ensure that the sample truly reflected the clinical characteristics relevant to the research objective namely, evaluating the rationality of antibiotic use under uncomplicated pneumonia conditions. Purposive sampling is methodologically acceptable when the researcher aims to select subjects based on specific clinical considerations that directly influence treatment evaluation (Sugiyono, 2022).

In this context, antibiotic regimens for pneumonia can vary greatly depending on comorbid conditions such as diabetes mellitus, chronic obstructive pulmonary disease (COPD), chronic kidney disease, or cardiovascular disorders. These comorbidities often require individualized antibiotic adjustments, which could introduce heterogeneity and confounding factors into the analysis. Therefore, purposive sampling allowed the researchers to focus specifically on cases where antibiotic selection and duration could be evaluated under relatively standardized clinical conditions, improving internal consistency in the assessment of the Gyssens categories.

Inclusion criteria: (1) Patients diagnosed with pneumonia; (2) Patients who received antibiotic therapy for at least three days; (3) Inpatients under BPJS coverage from January to December 2024. Exclusion criteria: (1) Patients with comorbid diseases; (2) Incomplete medical records. The decision to exclude patients with clinically significant comorbidities was made to reduce confounding factors that might bias the assessment of antibiotic rationality. Comorbidities can influence antibiotic choice, dosage, and duration due to renal function impairment, immune status differences, or risks of complications. Including such cases without stratified analysis could have led to misinterpretation of the Gyssens results, particularly in categories related to drug selection and duration.

Thus, the exclusion criterion was implemented not to simplify the sample artificially, but to maintain methodological rigor and ensure a more accurate evaluation of adherence to guideline-based therapy for pneumonia in its more typical, uncomplicated form. The minimum sample size was determined using the Slovin formula with a 10% margin of error, yielding 86 subjects from a total of 595 eligible patients. This number was considered sufficient to meet the analytical needs of a descriptive observational study and to maintain statistical representativeness (Berger et al., 2012; Morshed et al., 2009).

Slovin's formula is stated as follows:

$$n = \frac{N}{1 + N(e)^2}$$

Description:

n: Number of Samples

N: Population Size

e: Error Tolerance

Given:

Population Size (*N*) = 595 Patients

Error Tolerance (*e*) = 10% or 0.10

Therefore,

$$n = \frac{595}{1 + 595(0,10)^2}$$

$$n = \frac{595}{1 + 595(0,01)}$$

$$n = \frac{595}{1 + 5,95}$$

$$n = \frac{595}{6,95}$$

$$n = 85,6$$

Thus, the final sample consisted of 86 patients, statistically sufficient to represent the population.

Research Instrument

The main research instrument was an antibiotic use evaluation sheet based on the Gyssens method, developed by Gyssens. (2011), and widely recognized internationally for assessing antibiotic rationality in healthcare facilities (Gyssens, 2011; Pulcini & Gyssens, 2013). The Gyssens method classifies antibiotic therapy rationality into the following categories:

Category 0: Rational use (appropriate indication, drug, dose, interval, duration, and route).

Category I: Incorrect timing of administration.

Category IIa: Incorrect dosage.

Category IIb: Incorrect dosing interval.

Category IIIa: Duration too short.

Category IIIb: Duration too long.

Category IVa: Inappropriate antibiotic choice (spectrum or efficacy).

Category IVb: Incorrect route of administration.

Category V: No indication for antibiotic use.

Category VI: Insufficient data for assessment.

Data Analysis

Data were analyzed quantitatively and descriptively by calculating the percentage distribution of each Gyssens category. Statistical analysis was conducted using SPSS version 26 (IBM Corp., 2020). The results were presented in frequency tables and proportional charts, accompanied by narrative interpretation to describe antibiotic use patterns at Hospital X. This analytical approach aligns with previous studies by (Handayany & Yuliana, 2023) and (Wori

et al., 2025), which evaluated antibiotic rationality in pneumonia patients using the Gyssens method. The analysis aimed to provide a comprehensive overview of adherence to clinical guidelines and identify factors contributing to inappropriate antibiotic use in the hospital. Moreover, the findings are expected to serve as a foundation for developing clinical pharmacy interventions and improving antibiotic stewardship policies in line with Indonesia's National Antimicrobial Resistance Control Program (PPRA) established by the Ministry of Health of the Republic of Indonesia (Kemenkes RI, 2021).

Results and Discussion

Description of Research Subjects

This study on the evaluation of the rationality of antibiotic use in pneumonia patients was an observational retrospective study conducted on hospitalized pneumonia patients at the Hospital X. The study employed a descriptive design, analyzing patient medical record data using the Gyssens method to assess the appropriateness of antibiotic use based on categories that include indication, drug selection, dosage, interval, and duration of therapy. The results were presented in tables and expressed as percentages to describe patient characteristics, patterns of antibiotic use, types of antibiotics administered, and the level of rationality in their use. The collected data were then compared with the Guidelines for Antibiotic Use issued by the Indonesian Ministry of Health (Regulation No. 28 of 2021) and relevant scientific literature, to evaluate the conformity of clinical practices in the hospital with rational antibiotic therapy standards (Kementerian Kesehatan Republik Indonesia, 2021).

Patient Characteristics Based on Gender

Based on 86 patient medical records meeting the inclusion criteria, it was found that male patients accounted for 51 cases (59.3%), while female patients accounted for 35 cases (40.7%). These findings indicate that pneumonia was more prevalent among male patients than female patients. This result aligns with data from the Indonesian Basic Health Research (Riskesdas, Ministry of Health, 2018), which reported that pneumonia cases occur more frequently in men than in women.

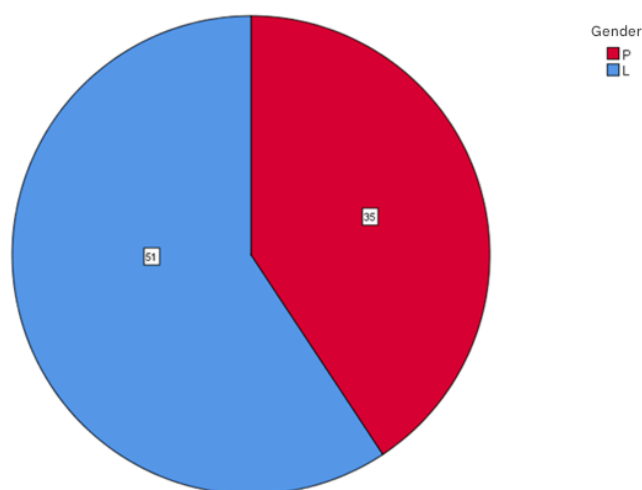


Figure 1. Distribution of Respondents by Gender

Antibiotic Use Patterns and Critical Evaluation

The analysis showed that Ceftriaxone (34.88%), Azithromycin (32.56%), and Levofloxacin (32.56%) were the three most frequently prescribed antibiotics for pneumonia patients at Hospital X. Although this distribution suggests variability in prescribing behavior, a deeper examination reveals several concerns regarding the appropriateness of these choices when

assessed against clinical context, guideline recommendations, and antimicrobial stewardship principles.

Need for Contextual Analysis Beyond Pharmacological Description

While the pharmacological profiles of Ceftriaxone, Azithromycin, and Levofloxacin explain why these agents are commonly used for community-acquired pneumonia (CAP), the prescribing pattern observed in this study raises questions about whether these antibiotics were selected based on: (1) Local microbiological data; (2) Institutional antibiogram; (3) Individual patient factors; (4) Evidence-based guideline adherence. The nearly equal distribution of the three antibiotics suggests that prescribing decisions may not have been driven by microbiological evidence but rather by clinician preference or habit. This is particularly important for Ceftriaxone, which was used most frequently as empirical therapy. Without data on local pathogen prevalence or resistance rates, it remains unclear whether third-generation cephalosporins are clinically indicated or potentially overused an issue that can accelerate resistance to β -lactam antibiotics.

Absence of Local Resistance Pattern Analysis

A major limitation is the absence of hospital-specific resistance data to determine whether the antibiotics used were likely to be effective against dominant pathogens in this setting. For example: (1) Rising macrolide resistance in Southeast Asia has reduced the effectiveness of Azithromycin in several regions; (2) Fluoroquinolone resistance, especially among Gram-negative pathogens, has been increasing nationwide. If similar trends exist at Hospital X, the frequent use of Azithromycin and Levofloxacin would be clinically concerning. Moreover, it is unclear whether hospital antibiotic stewardship policies restrict fluoroquinolone use, or whether prescribers documented appropriate justification when selecting these agents.

Critical Evaluation of Levofloxacin Use

The high proportion of Levofloxacin prescriptions (32.56%) warrants further scrutiny. Fluoroquinolones are not interchangeable alternatives and should be reserved for specific indications such as: (1) Severe β -lactam allergy; (2) Treatment failure with first-line therapy; (3) Confirmed susceptibility requiring fluoroquinolone coverage. Their widespread use is concerning because fluoroquinolones carry well-documented risks, including: (1) Tendinopathy and tendon rupture; (2) QT prolongation; (3) *C. difficile* infection; (4) Rapid selection of resistant organisms. However, the narrative in the original discussion treated Levofloxacin as equivalent to Ceftriaxone or Azithromycin without assessing whether its use was truly justified. This gap weakens the interpretability of rationality assessments and limits the utility of the study for antibiotic stewardship improvement.

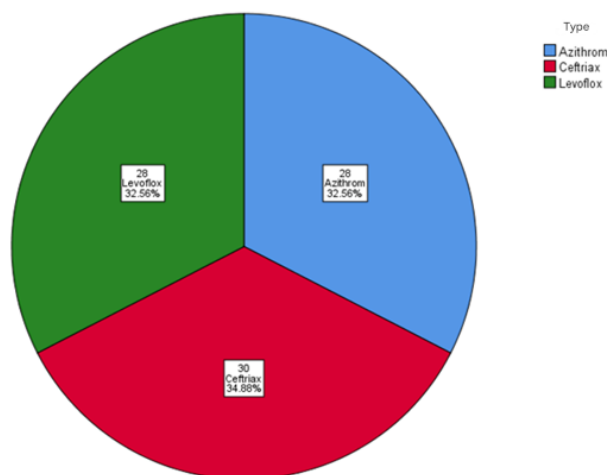


Figure 2. Proportion of Antibiotic Types Prescribed

Duration of Antibiotic Administration

The analysis of the duration of antibiotic use based on the type of antibiotic administered aims to identify the pattern of therapy duration applied to pneumonia patients in the hospital where the study was conducted. The length of antibiotic use serves as an important indicator in evaluating the rationality of therapy, as a duration that is too short may result in suboptimal treatment of the infection.

Table 1. Cross-Tabulation of Antibiotic Type and Duration of Use

Duration of Use	Day	Type			Total
		Azithrom	Ceftriax	Levoflox	
	3	1	0	0	1
	4	0	0	1	1
	5	17	21	8	46
	6	3	4	2	9
	7	5	5	17	27
	8	2	0	0	2
Total		28	30	28	86

Based on the cross-tabulation between the duration of antibiotic use and the types of antibiotics administered, it was found that most pneumonia patients underwent antibiotic therapy for five days, accounting for 46 cases. In this group, Azithromycin was used in 17 cases, Ceftriaxone in 21 cases, and Levofloxacin in 8 cases. This finding indicates that a five-day antibiotic course was the most commonly applied duration by medical practitioners in the hospital and is generally consistent with community-acquired pneumonia treatment guidelines, which recommend 5–7 days of antibiotic therapy depending on the patient’s clinical condition and therapeutic response. Among the total 86 cases observed, the tabulated results also revealed variations in antibiotic duration ranging from 3 to 8 days, with each antibiotic type showing different trends in frequency and duration of administration.

The Results Of Antibiotic Use Evaluation Based On The Gyssens Category

Table 2. Evaluation of Antibiotic Use Based on Gyssens Criteria

Gyssens Category	Gyssens criterion	Number of Cases	Percentage (%)
VI	No positive data / cannot be assessed	0	0
V	No positive data / cannot be assessed	0	0
IVa	Inappropriate administration interval	0	0
IVb	Inappropriate administration route	0	0
IVc	Inappropriate dose	0	0
IVd	Inappropriate duration of administration	0	0
IIIa	Antibiotic spectrum too broad	8	9,3
IIIb	Antibiotic spectrum too narrow	5	5,81
IIa	Antibiotic selection not according to guidelines	10	11,63
IIb	No indication for antibiotic use	0	0
IIc	Irrational antibiotic combination	0	0
I	More effective, safe, or inexpensive antibiotic alternatives exist	6	6,98
0	Rational / appropriate antibiotic use	57	66,28
Total		86	100

The table above presents the evaluation results of antibiotic use based on the Gyssens categorization for a total of 86 cases. The findings show that the majority of antibiotic use fell into Category 0 (rational use), accounting for 57 cases (66.28%), indicating that antibiotics were prescribed with appropriate dosage, route, interval, and indication in accordance with treatment guidelines. A smaller proportion of cases fell into Category IIIa (9.30%) and Category IIIb (5.81%), reflecting inaccuracies in the selection of antibiotic spectrum either too broad or too narrow. Additionally, Category IIa (11.63%) indicated antibiotic use inconsistent with treatment guidelines, while Category I (6.98%) suggested that a more effective, safer, or more economical alternative antibiotic could have been used. No cases were found in Categories VI, V, IVa, IVb, IVc, IVd, IIb, or IIc, meaning that all data were assessable and no errors were identified in terms of dosage interval, route of administration, duration, indication, or antibiotic combination.

Conclusion

Based on the results of this study, it can be concluded that the use of antibiotics in pneumonia patients at Hospital X was mostly rational according to the Gyssens method, with Category 0 (rational use) accounting for 66.28% of the total 86 cases. The most frequently used antibiotics were Ceftriaxone (34.88%), followed by Azithromycin (32.56%) and Levofloxacin (32.56%), with the most common duration of therapy being five days (53.9%), consistent with the Ministry of Health Guidelines (Permenkes No. 28 of 2021) and IDSA/ATS (2023) recommendations. However, some instances of inappropriate antibiotic use were identified, particularly related to spectrum selection (Categories IIIa and IIIb) and deviations from treatment guidelines (Category IIa). These findings highlight the need to strengthen the Antimicrobial Resistance Control Program (PPRA) in hospitals through regular antibiotic use monitoring, prescription audits, and periodic updates of clinical guidelines in line with local resistance patterns.

Suggestion

Continuous training for healthcare professionals on the principles of rational antibiotic use and the application of the Gyssens method is necessary. Additionally, prospective studies with larger sample sizes are recommended to further assess the relationship between the rationality of antibiotic use and clinical outcomes in pneumonia patients.

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