

Evaluation of Rational Antibiotic Use in Community Acquired Pneumonia Patients at RSUD Dr. Harjono Ponorogo

Iswandi¹, Samuel Budi Harsono², Farda Hakimah^{3*}

^{1,2,3}) Faculty of Pharmacy, Setia Budi University, Indonesia

e-mail:

fardaahakimah@gmail.com

ABSTRACT

Pneumonia remains a major health problem in Indonesia, with a national prevalence of 0.48% based on health worker diagnosis. Irrational antibiotic use may increase bacterial resistance, prolong hospitalization, and worsen clinical outcomes. This study aimed to evaluate the rationality of antibiotic use in adult community-acquired pneumonia (CAP) patients at RSUD Dr. Harjono Ponorogo, analyze its association with clinical outcomes, and identify factors contributing to irrational antibiotic use. This analytic observational study employed a retrospective cohort design involving adult CAP inpatients treated from January to December 2023. The rationality of antibiotic therapy was evaluated using the Gyssens method based on the American Thoracic Society/Infectious Diseases Society of America (ATS/IDSA) guidelines and the Indonesian National Guidelines for Medical Services. Data were analyzed descriptively and inferentially using the chi-square test. The results showed that 69% of patients received rational antibiotic therapy, while 31% received irrational therapy. Clinical outcomes were predominantly categorized as improved (74.7%) with an average length of stay of 3 to 5 days. Statistical analysis demonstrated a significant association between rational antibiotic use and favorable clinical outcomes ($p=0.028$; $OR=3.58$). Fishbone analysis identified several contributing factors to irrational antibiotic use, including patient-related factors, healthcare providers, drug availability, laboratory support, and managerial aspects. In conclusion, rational antibiotic use was significantly associated with better clinical outcomes in CAP patients. These findings highlight the importance of optimizing antibiotic stewardship programs to improve pneumonia management in regional hospitals.

Keywords: antibiotic rationality; community-acquired pneumonia; clinical outcomes; Gyssens method; antibiotic stewardshi

Introduction

Pneumonia is an acute infection of the lung parenchyma and remains a major cause of morbidity and mortality worldwide. Community-acquired pneumonia (CAP) is the most common type of pneumonia, with an incidence ranging from 1.5–14 cases per 1,000 population annually and mortality rates reaching 12–14% among hospitalized patients (Metlay et al., 2019; Torres et al., 2021). In 2017, pneumonia contributed to more than 800,000 deaths in children under five years

worldwide, while incidence and mortality among adults remain high, particularly in elderly patients and individuals with comorbidities (Quinton et al., 2018). In addition to bacterial causes such as *Streptococcus pneumoniae*, viral etiologies including influenza and SARS-CoV-2 have been increasingly reported (Cillóniz et al., 2022). In Indonesia, *Streptococcus pneumoniae* remains an important pathogen in community-acquired pneumonia and has demonstrated antimicrobial resistance patterns that may affect antibiotic selection and therapeutic outcomes (Amanda et al., 2021).

In Indonesia, pneumonia continues to be a significant public health problem. National health survey data reported a prevalence of 0.48% based on diagnosis by healthcare professionals, increasing to 10.8% when symptom-based cases were included. Higher prevalence rates were identified among children under five years and elderly populations, with disparities observed across regions and socioeconomic groups (Badan Kebijakan Pembangunan Kesehatan, 2023). These findings indicate that effective and rational management strategies are required to improve clinical outcomes and reduce the burden of pneumonia in healthcare facilities.

Antibiotics remain the cornerstone of CAP therapy. Appropriate empirical antibiotic therapy has been associated with improved prognosis, shorter length of hospital stay, and prevention of complications (Metlay et al., 2019). Conversely, irrational antibiotic use may contribute to antimicrobial resistance, increased healthcare costs, prolonged hospitalization, and poor clinical outcomes (Llor & Bjerrum, 2014). Antimicrobial stewardship programs and appropriate antibiotic prescribing are important strategies to reduce antimicrobial resistance, improve patient safety, and optimize clinical outcomes in hospital settings (Baur et al., 2017; Berrevoets et al., 2017). The World Health Organization has identified antimicrobial resistance as one of the major global public health threats requiring urgent intervention (Cherazard et al., 2017). Evaluation of antibiotic rationality can be performed using the Gyssens method, which assesses the appropriateness of antibiotic indication, drug selection, dosage, interval, duration, and route of administration (Van der Meer & Gyssens, 2001). Previous studies demonstrated that adherence to antibiotic guidelines was associated with better clinical outcomes, including shorter hospitalization and lower mortality rates (Fanning et al., 2014; Webb et al., 2019).

Several studies in Indonesia have evaluated antibiotic use in pneumonia patients. Previous studies mainly focused on empirical antibiotic therapy, bacterial profiles, antibiogram patterns, and the rationality of antibiotic use in pediatric patients or patients with specific comorbidities (Elvionita et al., 2022; Savitri et al., 2021; Sundariningrum et al., 2020; Yulia et al., 2020). Ariyanti et al. (2022) reported that rational antibiotic therapy in community-acquired pneumonia patients with type 2 diabetes mellitus was significantly associated with better clinical outcomes, while Oktaviani and Hamid (2024) demonstrated that appropriate antibiotic use was associated with shorter hospitalization in CAP patients. However, studies evaluating the association between antibiotic rationality and clinical outcomes in adult CAP patients, particularly those incorporating root-cause analysis of irrational

antibiotic use in regional hospitals, remain limited. To our knowledge, no previous study has evaluated antibiotic rationality using the Gyssens method and explored the contributing factors through fishbone analysis among adult CAP patients at RSUD Dr. Harjono Ponorogo. Therefore, this study aimed to evaluate the rationality of antibiotic use using the Gyssens method, analyze its association with clinical outcomes, and identify factors contributing to irrational antibiotic use through fishbone analysis. The findings are expected to provide local evidence to support antimicrobial stewardship and improve pneumonia management in regional hospitals.

Methodology

This study employed an analytic observational design with a retrospective cohort approach to evaluate the rationality of antibiotic use and its association with clinical outcomes in adult patients with community-acquired pneumonia (CAP). Secondary data were obtained from medical records of adult CAP patients hospitalized at RSUD Dr. Harjono Ponorogo during the period of January–December 2023.

The study population consisted of all hospitalized adult CAP patients who met the inclusion criteria: (1) male or female patients aged ≥ 18 years; (2) diagnosed with community-acquired pneumonia based on clinical and radiological findings; (3) received antibiotic therapy for at least 3 days; and (4) had complete medical records. Exclusion criteria included unreadable medical records, patients discharged against medical advice, and patients referred to another healthcare facility. After applying the eligibility criteria, a total of 87 patients were included in the study.

Data were collected using a structured data extraction sheet developed by the researchers to obtain demographic characteristics, clinical conditions, antibiotic regimens, and clinical outcomes from patients' medical records. Additional supporting information for fishbone analysis was obtained through brief interviews and observations involving healthcare personnel related to CAP management. To identify factors contributing to irrational antibiotic use, fishbone (Ishikawa) analysis was conducted by synthesizing findings from medical record reviews and interview results. Fishbone analysis is widely used in healthcare quality improvement to identify root causes and contributing factors related to clinical and managerial problems (Carvalho et al., 2017). Contributing factors were categorized into several dimensions, including healthcare personnel, methods, materials, facilities, environment, and management aspects. Antibiotic rationality was evaluated using the Gyssens method based on the American Thoracic Society/Infectious Diseases Society of America (ATS/IDSA) guidelines and the Indonesian National Guidelines for Medical Services (PNPK) for pneumonia management. Data processing and statistical analysis were performed using IBM SPSS Statistics version 29.

The independent variable in this study was the rationality of antibiotic use, classified according to the Gyssens categories. The dependent variable was the clinical outcome of CAP patients. Clinical outcomes were evaluated based on patients' condition at discharge and categorized as recovered, improved, or died. For inferential analysis, outcomes were further grouped into favorable outcomes

(recovered and improved) and unfavorable outcomes (died). Length of hospital stay was also evaluated descriptively as a secondary outcome.

Descriptive statistics were used to summarize patient characteristics and antibiotic use patterns. The association between antibiotic rationality and clinical outcomes was analyzed using the chi-square test with a significance level of $p < 0.05$. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to estimate the strength of association between variables.

To identify factors contributing to irrational antibiotic use, fishbone (Ishikawa) analysis was conducted by synthesizing findings from medical record reviews and supporting qualitative information. Contributing factors were categorized into several dimensions, including healthcare personnel, methods, materials, facilities, environment, and management aspects.

The research hypothesis in this study was that rational antibiotic use is significantly associated with better clinical outcomes in adult patients with community-acquired pneumonia at RSUD Dr. Harjono Ponorogo.

Ethical approval for this study was obtained from the Health Research Ethics Committee of RSUD Dr. Harjono S. Ponorogo (No. 005421350211211420241023000/XI/KEPK/2024). Permission to access patients' medical records and conduct interviews with healthcare personnel was obtained prior to data collection.

Result and Discussion

A total of 87 adult patients with community-acquired pneumonia (CAP) met the inclusion criteria and were analyzed in this study. Patient characteristics included age, sex, comorbidities, type of antibiotic therapy, and length of hospital stay as presented in Table 1.

Table 1. Characteristics of pneumonia patients at Dr. Harjono Regional Hospital in 2023 (n = 87)

Characteristics	n (%)
Age	
18-60 years	58 (65,5%)
>60 years	30 (34,5%)
Sex	
Male	49 (56,3%)
Female	38 (43,7%)
Length of Stay	
3 to 5 days	59 (67,9%)
6 to 10 days	25 (28,7%)
11 to 15 days	2 (2,3%)
More than 15 days	1 (1,1%)
Number of Antibiotic Therapies	
Single	68 (78,2%)
Combination	19 (21,8%)
Comorbidities	
Present	47 (54%)
Absent	40 (46%)

Most patients had a length of stay of 3 to 5 days and received single antibiotic therapy. The presence of comorbidities in several patients indicates that CAP frequently occurs in patients with underlying diseases that may influence treatment response and clinical outcomes. These findings are consistent with previous studies reporting that CAP commonly occurs in adult patients with certain risk factors and comorbid conditions (Torres et al., 2021).

Evaluation of antibiotic rationality using the Gyssens method demonstrated that most antibiotic use was categorized as rational (category 0), while the remaining prescriptions were classified as irrational (Table 2). Irrational antibiotic use was mainly identified in the duration of therapy, dosage interval, and antibiotic selection. These findings indicate that antibiotic prescribing practices at RSUD Dr. Harjono Ponorogo generally referred to ATS/IDSA and PNPk guidelines, although several inconsistencies with recommended therapy were still identified. Similar findings have been reported in previous studies showing that inappropriate duration and antibiotic selection remain challenges in pneumonia management (Webb et al., 2019). Irrational antibiotic use may increase the risk of antimicrobial resistance, prolong hospitalization, and worsen clinical outcomes.

Table 2. Rationality of antibiotic use in pneumonia patients at Dr. Harjono Regional Hospital in 2023 (n = 87)

Rationality of antibiotic use	Category	n (%)
Rational	0	60 (69,0)
Irrational	IIIa	5 (5,8)
	IIIb	3 (3,4)
	IVa	5 (5,8)
	IVb	7 (8)
	IVc	7 (8)

Notes: According to the Gyssens classification, Category 0 indicates appropriate antibiotic use; IIIa indicates treatment duration longer than recommended; IIIb indicates treatment duration shorter than recommended; IVa indicates that a more effective antibiotic was available; IVb indicates that a less toxic alternative was available; and IVc indicates that a less expensive alternative with comparable effectiveness was available.

Table 3. Primary clinical outcomes of pneumonia patients at Dr. Harjono Regional Hospital in 2023 (n = 87)

Clinical outcome	n (%)
Recovered	3 (3,4)
Improved	65 (74,7)
Died	19 (21,9)

Clinical outcomes in this study were dominated by the improved category, followed by died and recovered outcomes (Table 3). For inferential analysis, recovered and improved categories were grouped as favorable outcomes. Statistical analysis demonstrated a significant association between antibiotic rationality and clinical outcomes ($p=0.028$). Patients who received rational antibiotic therapy were more likely to achieve favorable clinical outcomes compared with those receiving

irrational therapy (Table 4). These findings indicate that guideline-based antibiotic use contributes to improved clinical conditions in CAP patients. Previous studies also reported that adherence to antibiotic therapy guidelines is associated with improved therapeutic success and better clinical outcomes in pneumonia patients (Metlay et al., 2019).

Table 4. Association between antibiotic rationality and clinical outcomes in pneumonia patients at Dr. Harjono Regional Hospital in 2023 (n = 87)

Variable	χ^2 (df)	p-value	Odds Ratio
Rationality of antibiotic use × Clinical outcome	7.121 (2)	0.028	3.58

Although most patients demonstrated favorable clinical outcomes, mortality was still observed in some patients. This condition may have been influenced by several factors other than antibiotic rationality, including comorbidities, initial clinical condition, and severity of infection during hospitalization. Therefore, successful pneumonia management is not solely determined by appropriate antibiotic use but is also influenced by the overall clinical condition of the patient.

The contributing factors to irrational antibiotic use identified in this study are presented in Figure 1.

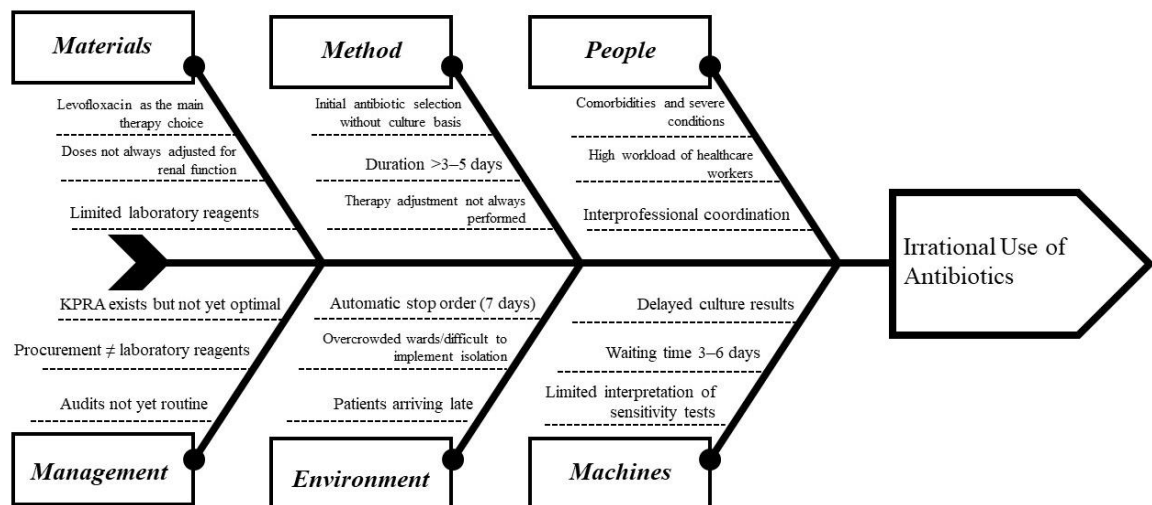


Figure 1. Fishbone Diagram of Factors Contributing to Irrational Antibiotic Use among Community-Acquired Pneumonia Patients at RSUD Dr. Harjono Ponorogo

Fishbone analysis demonstrated that irrational antibiotic use was influenced by several interconnected factors involving people, methods, materials, machines, environment, and management. Patient-related factors included severe clinical conditions and comorbidities, while healthcare personnel factors were associated with high workload, which may limit opportunities for regular reassessment of empirical antibiotic therapy and timely adjustment of treatment. Laboratory-related

factors, including delayed culture results and limited availability of laboratory reagents, may also contribute to prolonged empirical antibiotic use because definitive microbiological information is not immediately available. In addition, the identification of suboptimal implementation of KPRA activities, such as the absence of routine antibiotic audits, indicates that strengthening antimicrobial stewardship at the hospital level remains important to improve rational antibiotic use.

The findings of this study are generally consistent with previous studies conducted in Indonesia. Ariyanti et al. (2022) reported that rational antibiotic therapy in community-acquired pneumonia patients with type 2 diabetes mellitus was significantly associated with better clinical outcomes. Similarly, Oktaviani and Hamid (2024) found that appropriate antibiotic use was associated with shorter hospitalization among hospitalized CAP patients. In the present study, 69.0% of patients received rational antibiotic therapy, and rational antibiotic use was significantly associated with favorable clinical outcomes (OR = 3.58; $p = 0.028$). Unlike previous studies, this study further explored the underlying causes of irrational antibiotic use through fishbone analysis, providing additional insights into organizational and clinical factors that may influence antibiotic prescribing in a regional hospital setting.

Conclusion

This study showed that 69% of adult community-acquired pneumonia patients at RSUD Dr. Harjono Ponorogo received rational antibiotic therapy, which was significantly associated with better clinical outcomes and shorter hospital stay. Inappropriate duration and spectrum were the most common causes of irrational use. The fishbone analysis highlighted multiple contributing factors at the patient, healthcare worker, drug, laboratory, and management levels. The strength of this study lies in its use of real-world data from a public hospital and the combined use of the Gyssens method and fishbone analysis to identify root causes of irrational antibiotic use. However, as a retrospective study based on medical records, several clinical variables could not be fully controlled and microbiological confirmation was limited. Further prospective studies incorporating culture-based confirmation and intervention strategies are warranted. Based on these findings, the Pharmacy and Therapeutics Committee (KFT) and the Antimicrobial Resistance Control Committee (KPRA) at RSUD Dr. Harjono Ponorogo should strengthen antimicrobial stewardship through regular antibiotic use audits, optimization of culture-guided therapy, and multidisciplinary evaluation of antibiotic prescribing to improve the rationality of antibiotic use.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Reference

Amanda, G., Tafroji, W., Sutoyo, D. K., Burhan, E., Haryanto, B., & Safari, D. (2021). Serotype distribution and antimicrobial profile of *Streptococcus pneumoniae* isolated from adult patients with community-acquired pneumonia in Jakarta, Indonesia. *Journal of Microbiology, Immunology and Infection*, 54(6), 1175–1178. <https://doi.org/10.1016/j.jmii.2020.10.003>

Ariyanti, D., Sauriasari, R., & Yunir, E. (2022). Evaluation of current practice of antibiotic use and clinical outcomes of community-acquired pneumonia patients with type 2 diabetes mellitus at Dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia. *Indonesian Journal of Pharmacy*, 33(4), 583–591. <https://doi.org/10.22146/ijp.3572>

Badan Kebijakan Pembangunan Kesehatan. (2023). *Survei Kesehatan Indonesia (SKI) 2023 dalam angka*. Kementerian Kesehatan Republik Indonesia.

Baur, D., Gladstone, B. P., Burkert, F., Carrara, E., Foschi, F., Döbele, S., & Tacconelli, E. (2017). Effect of antibiotic stewardship on the incidence of infection and colonisation with antibiotic-resistant bacteria and *Clostridium difficile* infection: A systematic review and meta-analysis. *The Lancet Infectious Diseases*, 17(9), 990–1001. [https://doi.org/10.1016/S1473-3099\(17\)30325-0](https://doi.org/10.1016/S1473-3099(17)30325-0)

Berrevoets, M. A., Ten Oever, J., Oerlemans, A. J., Kullberg, B. J., Hulscher, M. E., & Schouten, J. A. (2017). Appropriate antibiotic use: Patient responsibility and physician accountability. *The Lancet Infectious Diseases*, 17(12), e288–e293. [https://doi.org/10.1016/S1473-3099\(17\)30448-3](https://doi.org/10.1016/S1473-3099(17)30448-3)

Carvalho, M., Santos, P., & Rocha, P. (2017). Using cause-and-effect analysis in healthcare improvement: A practical review. *International Journal for Quality in Health Care*, 29(4), 540–546.

Cherazard, R., Epstein, M., Doan, T. L., Salim, T., Bharti, S., & Smith, M. A. (2017). Antimicrobial resistant *Streptococcus pneumoniae*: Prevalence, mechanisms, and clinical implications. *American Journal of Therapeutics*, 24(3), e361–e369. <https://doi.org/10.1097/MJT.0000000000000551>

Cillóniz, C., Dominedò, C., & Torres, A. (2022). Multidrug resistant Gram-negative bacteria in community-acquired pneumonia. *Critical Care*, 26(1), 167. <https://doi.org/10.1186/s13054-022-04053-w>

Elvionita, D., Yuniarti, E., & Fadhilah, N. (2022). Evaluasi penggunaan antibiotik pada pasien pneumonia anak di rumah sakit. **Jurnal Kefarmasian Indonesia**, 12(1), 33–41. <https://doi.org/10.22435/jki.v12i1.5412>

Fanning, M., McAloon, C. G., Schaffer, K., & Bennett, K. (2014). Adherence to guideline-based antibiotic treatment and clinical outcomes in community-acquired pneumonia. *Irish Journal of Medical Science*, 183(4), 551–559. <https://doi.org/10.1007/s11845-013-1040->

Kurniawan, A., Prasetyo, Y. B., & Rahmawati, F. (2019). Evaluasi penggunaan antibiotik empiris pada infeksi saluran pernapasan akut di fasilitas kesehatan tingkat pertama. *Jurnal Manajemen dan Pelayanan Farmasi*, 9(4), 245–252.

Llor, C., & Bjerrum, L. (2014). Antimicrobial resistance: Risk associated with antibiotic overuse and initiatives to reduce the problem. *Therapeutic Advances in Drug Safety*, 5(6), 229–241. <https://doi.org/10.1177/2042098614554919>

Metlay, J. P., Waterer, G. W., Long, A. C., Anzueto, A., Brozek, J., Crothers, K., Cooley, L. A., Dean, N. C., Fine, M. J., Flanders, S. A., Griffin, M. R., Metersky, M. L., Musher, D. M., Restrepo, M. I., & Whitney, C. G. (2019). Diagnosis and treatment of adults with community-acquired pneumonia. *American Journal of Respiratory and Critical Care Medicine*, 200(7), e45–e67. <https://doi.org/10.1164/rccm.201908-1581ST>

Oktaviani, F., & Hamid, H. B. (2024). Qualitative analysis of antibiotic use in community-acquired pneumonia cases in inpatients at a government hospital Batam City. *Indonesian Journal of Advanced Research*, 3(12), 2055–2064. <https://doi.org/10.55927/ijar.v3i12.12477>

Quinton, L. J., Walkey, A. J., & Mizgerd, J. P. (2018). Integrative physiology of pneumonia. *Physiological Reviews*, 98(3), 1417–1464. <https://doi.org/10.1152/PHYSREV.00032.2017>

Savitri, D., Anggraini, D., & Lestari, F. (2021). Profil penggunaan antibiotik empiris dan definitif pada pasien pneumonia di rumah sakit. *Media Farmasi Indonesia*, 16(2), 145–153.

Sundariningrum, F. S., Wibowo, T. A., & Hapsari, W. S. (2020). Evaluasi penggunaan antibiotik dengan metode Gyssens pada pasien pneumonia anak di ruang intensive care unit. *Jurnal Farmasi Klinik Indonesia*, 9(2), 112–120.

Torres, A., Cilloniz, C., Niederman, M. S., Menéndez, R., Chalmers, J. D., Wunderink, R. G., & van der Poll, T. (2021). Pneumonia. *Nature Reviews Disease Primers*, 7(1). <https://doi.org/10.1038/s41572-021-00259-0>

Van der Meer, J. W. M., & Gyssens, I. C. (2001). Quality of antimicrobial drug prescription in hospital. *Clinical Microbiology and Infection*, 7(Suppl. 6), 12–15. <https://doi.org/10.1046/j.1469-0691.2001.00066.x>

Webb, B. J., Sorensen, J., Jephson, A., Mecham, I., Dean, N. C., & Waterer, G. W. (2019). Broad-spectrum antibiotic use and poor outcomes in community-acquired pneumonia. *European Respiratory Journal*, 54(1), 1900057. <https://doi.org/10.1183/13993003.00057-2019>

World Health Organization. (2023). *Global antimicrobial resistance and use surveillance system (GLASS) report 2023*. World Health Organization.

Yulia, R., Mariza, J. W., Soedarsono, & Herawati, F. (2020). Bacterial profile and antibiotic use in pneumonia patients at Dr. Soetomo General Hospital. *Current Respiratory Medicine Reviews*, 16(1), 21–27. <https://doi.org/10.2174/1573398X16666200217122822>