



Borneo Journal o... 10.11

kepada hestirimahari... ^



Dari Borneo Journal of Pharmacy Farmasi •
bjop@umpr.ac.id

Kepada hestirimahariyani@gmail.com
rhienawidi@gmail.com
fauna@staff.ubaya.ac.id
nurulchusna99@gmail.com

Tanggal 4 Nov 2025, 10.11



Enkripsi standar (TLS).

[Lihat detail keamanan](#)

Dear Hesti Rima Hariyani, Rina Widiyawati, Fauna Herawati,
Nurul Chusna:

We have reached a decision regarding your submission to Borneo Journal of Pharmacy, "Analysis of Antibiotic Use in Outpatient Pneumonia Patients at X Blitar Health Center using the Gyssens Method and the Defined Daily Dose".

Submission ID: **11327**

Our decision is: **Accept Submission**

Your manuscript is scheduled for publication in **Volume 9 Issue 2 June 2026**

<https://journal.umpr.ac.id/index.php/bjop/article/view/11327>

A galley PDF of your manuscript will be available after all papers in the assigned issue are complete.

Analysis of Antibiotic Use in Outpatient Pneumonia Patients at X Blitar Health Center using the Gyssens Method and the Defined Daily Dose (DDD)

Hesti Rima Hariyani¹

Fauna Herawati^{1*}

Rina Widiyawati²

Nurul Chusna³

¹Department of Clinical Pharmacy,
Faculty of Pharmacy, University of
Surabaya, Surabaya 60293, Indonesia

²Department of Doctoral Programs,
University of STRADA Indonesia,
Indonesia

³Universitas Muhammadiyah
Palangkaraya

*email: fauna@staff.ubaya.ac.id; phone:
+6289650067999

Abstract

Pneumonia is one of the respiratory infections that is still a public health problem and requires appropriate antibiotic therapy. However, irrational use of antibiotics has the potential to increase resistance and worsen patient clinical outcomes. This study aims to analyze antibiotic use in outpatient pneumonia patients at the X Blitar Health Center using the Defined Daily Dose (DDD) and Gyssens methods. This study employed a cross-sectional approach, utilizing secondary data from 109 medical records and prescriptions for pneumonia patients (ICD-10 codes J12-J18) from February 2024 to May 2025. Quantitative analysis was conducted using the DDD/1,000 patients per day method, while qualitative analysis of prescriptions was performed using the Gyssens method. The results showed that Amoxicillin (J01CA04) was the most widely used antibiotic, namely 232.42 DDD/1,000 patients per day, followed by Cefadroxil (87.04 DDD/1,000 patients per day), Ciprofloxacin (18.35 DDD/1,000 patients per day), and Azithromycin (15.29 DDD/1,000 patients per day). Gyssens' analysis revealed that most prescriptions fell into category IIA (33.94%), category IVA (29.36%), and category V (27.52%). Inaccurate dosage and suboptimal antibiotic selection were the leading causes of irrational antibiotic use. Additionally, 30 pneumonia patients were identified who did not receive antibiotics despite having clinical indications for them. The results of this study emphasize the need for rationalization training in therapy, prescription audits, and strengthening the implementation of clinical guidelines in



INTRODUCTION

Antibiotic resistance has become a serious threat to public health worldwide. The World Health Organization (WHO) states that it is one of the top global threats that requires immediate attention^{1,2}. Antimicrobial resistance (AMR) not only threatens the effectiveness of treatment but also worsens the health burden, with projections reaching 10 million deaths per year by 2050 if not controlled^{3,4}.

Inappropriate use of antibiotics, including selecting the type, dose, and duration of administration, is the leading cause of increasing

resistance in pathogenic bacteria that cause serious infections, including pneumonia⁵⁻⁷. Pneumonia itself is the most common respiratory tract infection and is a significant cause of morbidity and mortality in the world⁸⁻¹⁰. Globally, pneumonia causes more than 2.5 million deaths each year, with young children and the elderly being the most vulnerable populations^{3,4}. Thus, pneumonia is the primary focus in controlling the rational use of antibiotics.

Indonesia, especially at the health center level, the main gateway for primary health care services, has special challenges in handling pneumonia cases. Based on data from the Ministry of Health of the Republic of Indonesia, pneumonia is among the five most common diseases. The number of visits continues to

increase every year^{11,12}. Health centers often face limitations related to diagnostic facilities, variations in the competence of health workers, and high service time pressure^{13,14}. These conditions have the potential to increase suboptimal antibiotic prescriptions both in terms of choosing the wrong type of antibiotic, inappropriate dosage, and inadequate duration of therapy^{15,16}. In addition, the monitoring and evaluation system for antibiotic use has not been appropriately standardized. The lack of an audit and feedback system makes it challenging to supervise prescribing practices, ultimately contributing to increased resistance and wasteful health costs. Therefore, stricter and more measurable guidelines are urgently needed to manage pneumonia cases at the primary care level¹⁷.

Literature review shows that research evaluating antibiotic use in pneumonia in Indonesian health centers is still limited. Most studies focus on inpatient services or secondary hospitals, and the evaluation methods used are generally not comprehensive^{18,19}. The use of internationally standardized antibiotic evaluation methods, such as the Gyssens method to assess the quality of antibiotic use and the Defined Daily Dose (DDD) method to measure the amount of antibiotic consumption, is rarely applied comprehensively, especially at the primary care level^{20,21}.

The Gyssens method is an effective qualitative method for evaluating the quality of antibiotic use based on the criteria of indication, drug selection, dosage, administration interval, and duration of therapy^{3,22}. Meanwhile, quantitative methods such as the Defined Daily Dose (DDD) developed by the WHO Collaborating Centre for Drug Statistics Methodology provide standard units of measurement for comparing antibiotic consumption between health facilities and over time²³. Combining the two provides a comprehensive mapping of antibiotic use volume and quality.

Unfortunately, there has not been much research integrating these two methods in evaluating antibiotic use in pneumonia cases in primary health care facilities in Indonesia.

Research by Syam, R.A & Karuniawati, H (2024) shows that a combination of the Gyssens method and DDD/1,000 patients per day can provide a more comprehensive evaluation of rational antibiotic use programs²¹. Specific data on the characteristics of rational antibiotic use. Specific data on the characteristics of antibiotic use in pneumonia in Indonesian health centers are also still minimal, even though this information is essential for developing targeted intervention strategies²⁴.

With limited data on antibiotic use in pneumonia at the health center level, this study was designed to analyze antibiotic use in pneumonia patients at the health center using a combination of the Gyssens and DDD methods. The Gyssens method was used to analyze the quality of antibiotic use based on indication, drug selection, dosage, administration interval, and duration of therapy. Meanwhile, the DDD/1,000 patients per day method will be used to measure and compare the quantity of antibiotic consumption in a standardized manner. Integrating these two methods is expected to provide a comprehensive picture of antibiotic use patterns, identify areas that need improvement, and provide evidence-based recommendations for optimizing antibiotic use in pneumonia cases at the health center. The results of this study can be the basis for developing an antimicrobial stewardship program based on the conditions of primary health care in Indonesia.

MATERIALS AND METHODS

Materials

This study employed a cross-sectional design, combining both quantitative and qualitative approaches, to analyze antibiotic use among pneumonia patients at community health centers. Ethical approval was obtained from the Institutional Ethics Committee of the University of Surabaya under number 650/KE/VII/2025.

The research was conducted at Community Health Center X, located in the Blitar area, from July to August 2025. Data were collected from the medical records of patients diagnosed with pneumonia (ICD-10 codes J12-J18) covering the period from February 2024 to May 2025. The site

was selected purposively because Community Health Center X maintains complete and well-documented medical records.

This study's population was all patients with respiratory tract infections treated at the Community Health Center X. The study sample was patients diagnosed with pneumonia (ICD-10 J12-J18), with inclusion criteria being complete medical records and exclusion criteria being referred without prior treatment. The sampling technique used was total sampling for all cases that met the inclusion and exclusion criteria.

The research material, secondary data obtained from the medical records of pneumonia patients, includes patient demographic data, complete diagnosis, antibiotic type, dose, administration frequency, and therapy duration. Data were collected using a simple data collection sheet to calculate DDD/1,000 patients per day and the Gyssens test.

Methods

Two methods were used in this study: the WHO Defined Daily Dose (DDD) method as a quantitative approach and the Gyssens method as a qualitative analysis tool based on prescription accuracy. DDD is useful for comparing antibiotic consumption levels between populations, while Gyssens allows classification based on clinical parameters, including indications, doses, duration, and effectiveness.

WHO Collaborating Centre for Drug Statistics Methodology (2022) and Gyssens et al. (1992) have stated that the combination of the two methods can provide a comprehensive picture of the volume and quality of antibiotic use^{23,25}.

Analysis of the quantity of antibiotic use using the DDD method established by WHO was carried out using the formula:

$$\frac{DDD}{1000} \text{ patients per day} = \frac{\text{Total drug (gram)} \times 1.000}{DDD \text{ WHO (gram)} \times \text{Total Patient}}$$

Description: Total drug = amount of antibiotic use for 1 month (grams); WHO DDD is a standard that refers to the ATC/DDD guidelines; The number 1,000 indicates 1,000 outpatients; Total patients is the total number of patients with pneumonia served by health center X.

Analysis of the quality of antibiotic use was conducted using the Gyssens method which classifies antibiotic use into several categories including category 0 (appropriate use); category I (improper use of time); category IIA (inappropriate use of dose); category IIB (improper use of interval); category IIC (improper use of route); category IIIA (use of antibiotics for too long); category IIIB (use of antibiotics for too short); category IVA (other antibiotics are more effective); category IVB (other antibiotics are safer); category IVC (other antibiotics are cheaper); category IVD (there are other antibiotics with a narrower spectrum); category V (no indication); category VI (incomplete data).

RESULTS AND DISCUSSION

Table I shows the distribution of pneumonia patient characteristics based on age group and gender. The toddler age group (12-59 months) was the most dominant group, at 37.78%, followed by adults (20-59 years) at 25.69% and older people (> 60 years) at 13.76%. These results indicate that pneumonia is still the primary infectious disease that attacks vulnerable age groups, especially young children and the elderly, who have immature immune systems or have experienced decreased immune function. This finding is supported by the WHO report (2023) and research by Troeger et al. (2018), which states that pneumonia is the leading cause of death in toddlers and infectious complications in the elderly in developing countries^{3,25}.

Physiologically, the immune system of toddlers (<5 years) is not fully developed, so they have a lower ability to fight respiratory tract infections such as pneumonia. In addition, children have smaller airway diameters than adults, which causes increased airflow resistance and makes it easier for mucus to block when an infection occurs²⁶. This condition is exacerbated by malnutrition, exposure to indoor air pollution, and lack of exclusive breastfeeding. Studies by Shalini et al. (2024) and Al-Khubayasi et al. (2023) showed that most cases of pneumonia in toddlers were associated with a lack of good nutritional status, low immunization status, and crowded living environments^{27,28}.

The dominance of male patients (55.05%) shown in Table I also aligns with a study in South Africa by Guma et al. (2022), which noted a higher prevalence of pneumonia in males than females²⁹. Biologically, this can be explained by hormonal differences that affect the immune system. Estrogen hormones in women are known to protect against infection by increasing B cell activation and antibody production, while testosterone tends to decrease cellular immune responses. In addition, boys have a higher tendency towards exploratory behavior, which increases exposure to infectious agents^{26,30}.

In addition to biological factors, behavioral differences also contribute to the high incidence of pneumonia in male anal. Boys tend to have higher physical activity, often play outdoors, and are less supervised than girls, which can increase the possibility of exposure to infectious agents from the environment²⁵.

The diagnosis of pneumonia in these patients was dominated by J12.9 viral pneumonia unspecified (32.11%), J16 pneumonia due to other infectious organisms not elsewhere classified (25.69%), and pneumonia unspecified (20.18%), as

seen in Table I. The high number of nonspecific diagnoses reflects the limitations in supporting examinations at health centers. This is supported by a multicenter study in 12 primary clinics conducted by Rodriques-Contreras et al. (2022), which found that point-of-care lung ultrasound (POCUS) had a sensitivity of 87.8% but a specificity of only 58.5% compared to X-ray³¹. In addition, a meta-review conducted by Htun et al. (2019) in adults showed that symptoms such as temperature ≥ 38 oC and respiratory rate ≥ 20 times per minute had a moderately favorable likelihood ratio (LR + 3.2 – 3.5), but were clinically insufficient for diagnosis without imaging or biomarker confirmation³². These studies indicate that clinical diagnosis alone is no less accurate.

Limitations in diagnostic tests cause health workers to use non-specific ICD-10 codes. Etiological identification is essential for determining the need for antibiotics, especially to differentiate viral and bacterial pneumonia. WHO (2023) also emphasized that over-diagnosing bacterial pneumonia in viral cases contributes to irrational antibiotic use³³.

Table I. Distribution of Patient Characteristics

Characteristics		Frequency (n = 109)	Percentage (%)
Age			
Baby	(0 - 11 months)	8	7,34
Toddler	(12 - 59 months)	39	35,78
Child	(5 - 9 years)	26	23,85
Teenager	(10 - 19 years)	5	4,59
Mature	(20 - 59 years)	21	19,27
Elderly	(≥ 60 years)	10	9,17
Gender			
Female		49	44,95
Male		60	55,05
Diagnosis			
J12	Viral pneumonia	3	2,75
	J12.2 Parainfluenza virus pneumonia	1	0,92
	J12.9 Viral pneumonia, unspecified	35	32,11
J13	Pneumonia due to <i>Streptococcus pneumoniae</i>	1	0,92
J15	Bacterial pneumonia, not elsewhere classified	0	0,00
	15.8 Other bacterial pneumonia	2	1,83
	15.9 Bacterial pneumonia, unspecified	1	0,92
J16	Pneumonia due to other infectious organisms, not elsewhere classified	28	25,69
J18	Pneumonia, organism unspecified	16	14,68
	18.9 Pneumonia, unspecified	22	20,18

Amoxicillin was the most widely used antibiotic in the treatment of pneumonia in this study, with a consumption value of 232.42 DDD/1,000 patients per day (Table II). The figure shows that Amoxicillin contributed 65.82% of the total antibiotic consumption, according to WHO recommendations and national guidelines as the first line of treatment for community-acquired pneumonia. This is in line with the study of Limato et al. (2022), which stated that amoxicillin is the most widely used antibiotic for the treatment of outpatient pneumonia, and is reinforced by the study of Pitasari et al. (2025) at the Khomba Jayapura Health Center, which also

showed the dominance of amoxicillin use in the treatment of pneumonia^{34,35}.

Lower use of Azithromycin and Ciprofloxacin suggests a reduction in broad-spectrum antibiotics, which aligns with antimicrobial stewardship policies. Stewardship programmes in primary care in Tameside and Glossop also reduced the use of broad-spectrum antibiotics by 10.6% over the period 2019–2020³⁶. Similarly, a policy evaluation in England also showed a 24% reduction in fluoroquinolones, including ciprofloxacin, following a national intervention³⁷.

Table II. Results of Analysis of Antibiotic Use Based on DDD

No	ATC Code	Generic Name	Total Grams/DDD	DDD/1.000 patient per day	Percentage	Total Patients
1	J01CA04	Amoxicillin	25,33	232,42	65,82	109
2	J01DB05	Cefadroxil	9,49	87,04	24,65	
3	J01MA02	Ciprofoxacin	2,00	18,35	5,20	
4	J01FA10	Azitromicin	1,67	15,29	4,33	
Total			38,49	353,10	100,00	

A similar survey conducted by Kurniawati et al. (2021) showed that dosage errors were dominant in prescribing antibiotics for ARI in primary care facilities¹⁸. A study in Bangladesh also reported that 56.8% of pediatric prescriptions contained inappropriate antibiotic doses, either overdose or underdose³⁸. As many as 29.36% of prescriptions were in the VIA category (Table III), where the antibiotic chosen was not the most effective option. This indicates a lack of clinical information updates in primary care physician practices. Similar conditions were also seen in hospitals, where in antibiotic selection, 50% of patients received antibiotics that were not according to guidelines³⁹.

In Gyssens’ analysis, there were 30 cases (27.52%) that fell into category V, where the patient was diagnosed with pneumonia, but was not given antibiotics at all, even though clinically there were indications that they required antibiotic therapy. This indicates the potential for under-prescribing, where antibiotics should have been given but were not. Some possible causes include health workers assessing that the

pneumonia suffered was mild or caused by a virus (although the diagnosis did not state that a virus caused the pneumonia), lack of clarity in clinical classification and no support for laboratory or radiological examinations that caused doubt in making therapeutic decisions, errors in administrative factors (errors when choosing a diagnosis without intention)¹⁶.

This phenomenon differs from the general trend in primary care, which more often shows overprescribing. Studies by Mangione-Smith et al. (2015) and Shapiro et al. (2024) state that in some situations, such errors can also occur in the form of not providing therapy even though there is a strong indication to offer it^{40,41}. This may indicate the prescriber’s caution in giving antibiotics to prevent resistance, but it is not accompanied by strengthening the correct diagnosis, which can hurt patient recovery. Therefore, it is essential to enhance the clinical decision-making support system and ensure that guidelines are easily accessible and that socialized care is socialized when new guidelines exist.

Table III. Results of Gyssens' Analysis

Gyssens's Criterion		Frequency (n = 109)	Percentage (%)
Category 0	(correct)	7	6,42
Category I	(not on time)	0	0,00
Category IIA	(not on dose)	37	33,94
Category IIB	(not on interval)	0	0,00
Category IIC	(not on route)	0	0,00
Category IIIA	(used too long)	0	0,00
Category IIIB	(too short a time)	0	0,00
Category IVA	(used when too short)	32	29,36
Category IVB	(other safer antibiotics)	0	0,00
Category IVC	(other cheaper antibiotics)	0	0,00
Category IVD	(other narrow-spectrum antibiotics)	3	2,75
Category V	(no indication)	30	27,52
Category VI	(incomplete data)	0	0,00
Total		109	100

CONCLUSION

This study shows that the use of antibiotics in outpatient pneumonia patients at Puskesmas X Blitar is dominated by Amoxicillin (232.42 DDD/1,000 patients per day), followed by Cefadroxil, Ciprofloxacin, and Azithromycin. According to Gyssens' analysis, most antibiotic use falls into category IIA (inappropriate dose) and IVA (less effective antibiotic selection). There were also cases where patients diagnosed with pneumonia were not given antibiotics (category V). These results indicate the need for increased compliance with antibiotic therapy guidelines and dose rationalization training. Further research is recommended to evaluate the effectiveness of audit and feedback-based interventions and diagnostic aids in primary care.

ACKNOWLEDGMENT

The author would like to thank the Head of Puskesmas X Blitar and all staff who have given permission and supported the data collection process. Gratitude is also expressed to the Health Office for the administrative support provided. Special appreciation is given to the academic supervisor and proofreader who have helped

perfect the contents of this paper. The author also appreciates the assistance from all parties, which, although the author cannot mention one by one, have helped the smooth running of this research.

Authors' Contribution

Conflict of Interest

The author declares that no financial, personal, or institutional conflict of interest that could influence this research's implementation or results. This research was conducted independently without commercial sponsorship, pharmaceutical industry support, or funding from other external parties. The source of funding came entirely from the author's expenses, without intervention from any party in the planning, data collection, analysis, and writing of the manuscript. The author had full access to all research data and guarantees that no external sponsors or institutions were involved in the interpretation of the data or the decision to publish the results. Thus, the entire content and conclusions result from independent thinking and analysis free from external bias.

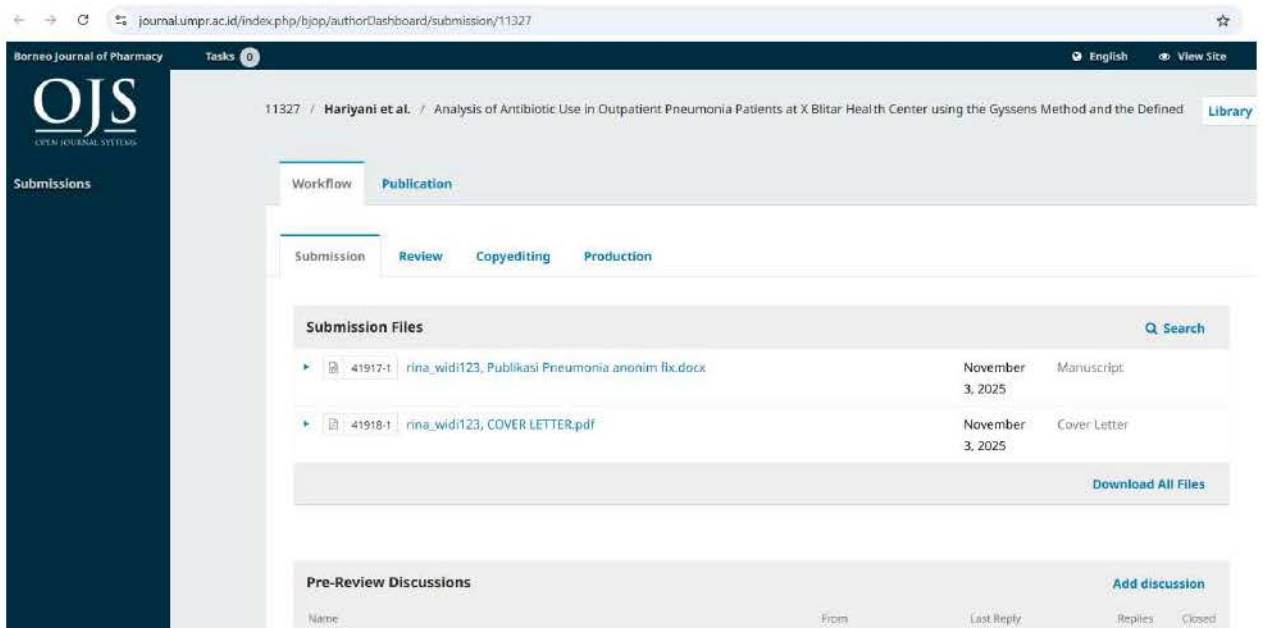
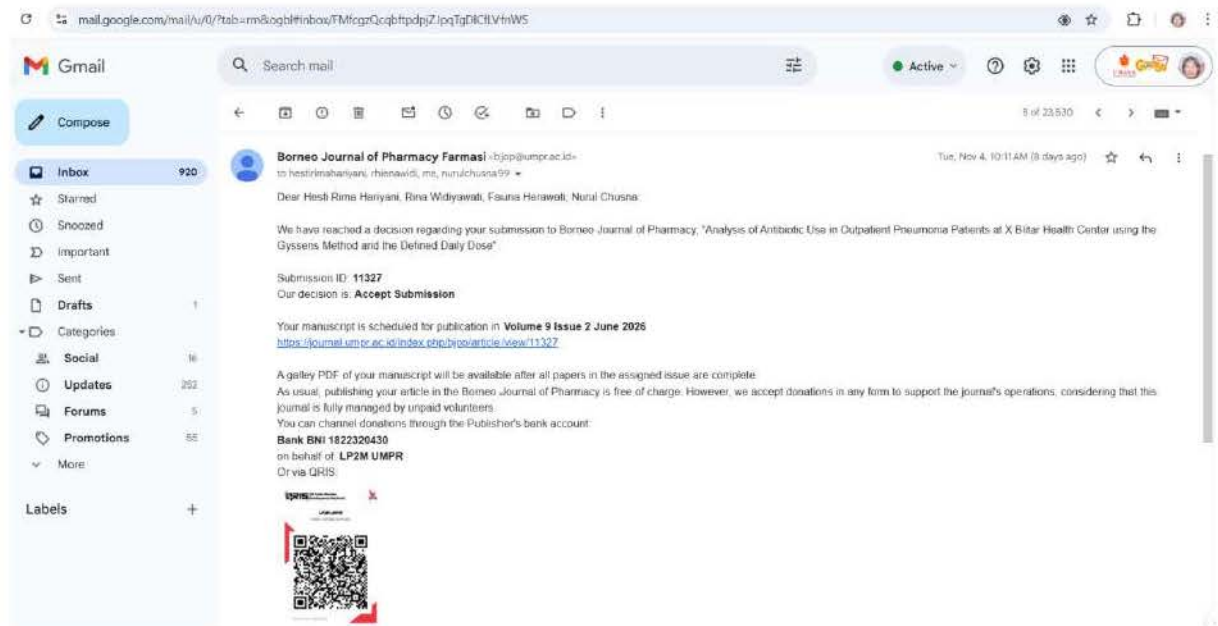
REFERENCES

1. World Health Organization. Ten threats to global health in 2019 [Internet]. Geneva: WHO Press. 2019. Available from: <https://www.commonwealthnurses.org/the-commonwealthnurse/Documents/Tenthreatstoglobalhealth.pdf>
2. Walsh TR, Gales AC, Laxminarayan R, Dodd PC. Antimicrobial Resistance: Addressing a Global Threat to Humanity. *PLoS Med* [Internet]. 2023;20(7 July):12–5. Available from: <http://dx.doi.org/10.1371/journal.pmed.1004264>
3. World Health Organization. Global antimicrobial resistance and use surveillance system (GLASS) report. WHO Publ [Internet]. 2023; Available from: <https://www.who.int/publications/i/item/9789240062702>
4. Murray CJ, Ikuta KS, Sharara F, Swetschinski L, Robles Aguilar G, Gray A, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet*. 2022;399(10325):629–55.
5. Dadgostar P. Antimicrobial resistance: Implications and costs. *Infect Drug Resist*. 2019;12::3903–3910.
6. Sartelli M, Barie PS, Coccolini F, Abbas M, Abbo LM, Abdukhalilova GK, et al. Ten golden rules for optimal antibiotic use in hospital settings: the WARNING call to action. *World J Emerg Surg*. 2023;18(1):1–35.
7. Mo Y, Oonsivilai M, Lim C, Niehus R, Cooper BS. Implications of reducing antibiotic treatment duration for antimicrobial resistance in hospital settings: A modelling study and meta-analysis. *PLoS Med* [Internet]. 2023;20(6 June):1–20. Available from: <http://dx.doi.org/10.1371/journal.pmed.1004013>
8. Jain S, Williams DJ, Arnold SR, Ampofo K, Bramley AM, Reed C, Stockmann C, Anderson EJ, Grijalva CG, Self WH, Zhu Y, Patel A, Hymas W, Chappell JD, Kaufman RA, Kan JH, Dansie D, Lenny N, Hillyard DR, Haynes LM, Levine M, Lindstrom S, Winchell JM, Katz JM, FLCEST. Community-acquired pneumonia requiring hospitalization among U.S. children. *N Engl J Med*. 2015;372(9)::835–45.
9. Cilloniz C, Dela Cruz CS, Dy-Agra G, Pagcatipunan RS. World Pneumonia Day 2024: Fighting Pneumonia and Antimicrobial Resistance. *Am J Respir Crit Care Med*. 2024;210(11):1283–5.
10. Ginsburg AS, Duncan K, Klugman KP, Srikanth P. Access to antibiotics for pneumonia and sepsis in LMICs. *Lancet Glob Heal* [Internet]. 2024;12(12):e1928–9. Available from: [http://dx.doi.org/10.1016/S2214-109X\(24\)00418-2](http://dx.doi.org/10.1016/S2214-109X(24)00418-2)
11. Kementerian Kesehatan Republik Indonesia. Profil Kesehatan Indonesia Tahun 2020 [Internet]. Jakarta: Kemenkes RI. 2021. Available from: [file:///C:/Users/hpryz/Downloads/Profil-Kesehatan-Indonesia-2020 \(1\).pdf](file:///C:/Users/hpryz/Downloads/Profil-Kesehatan-Indonesia-2020%20(1).pdf)
12. Epidemiolog.id. ISPA dan Pneumonia: Masalah Kesehatan pada Balita di Indonesia. [Internet]. 2025. Available from: https://www.epidemiolog.id/ispa-dan-pneumonia-masalah-kesehatan-pada-balita-di-indonesia/?utm_source=chatgpt.com
13. Haryanti F, Laksanawati IS, Arguni E, Widyaningsih SA, Ainun NA, Rastiwi N. Evaluation of the Implementation of Integrated Management of Childhood Illness in Special Region of Yogyakarta Province, Indonesia. *Open Access Maced J Med Sci*. 2022;10(B):570–5.
14. Wahyuni, Sri; Ferial L. Pemeriksaan Puskesmas di Daerah Terpencil terhadap Fasilitas Kesehatan. *J BAJA Heal Sci*. 2023;3(01):91–108.
15. Bellatasie R, Oktavia S, Mawarni KE, Adriani S, Wiliantari S. Evaluation of Antibiotic Prescription in Community-Acquired Pneumonia Patients with Gyssens Method. 2023;8(4):2057–62.
16. Sulis G, Adam P, Nafade V, Gore G, Daniels B, Daftary A, et al. Antibiotic prescription practices in primary care in low- And middle-income countries: A systematic

- review and meta-analysis. PLoS Med [Internet]. 2020;17(6):1–20. Available from: <http://dx.doi.org/10.1371/journal.pmed.1003139>
17. Guisado-Gil AB., Mejías-Trueba, M.; Peñalva G., Aguilar-Guisado, M.; Molina J., Gimeno, A.; Álvarez-Marín R., Praena, J.; Bueno, C.; Lepe JA. et al. Antimicrobial Stewardship in the Emergency Department Observation Unit: Definition of a New Indicator and Evaluation of Antimicrobial Use and Clinical Outcomes. *Antibiotics*. 2024;13(4):356.
 18. Kurniawan, Kris; Nuryastuti, Titik; Puspitasari I. Evaluasi Penggunaan Antibiotik Empirik Terhadap Outcome Klinik dan Gambaran Antibiotikogram Pada Pasien ISPA di Puskesmas Jetis Yogyakarta. *Maj Farm*. 2021;17(3):256–64.
 19. Hardiana, I; Laksmiawati, Dian Ratih; Ramadaniati, Hesti Utama; Sutarno S. EVALUASI PENGGUNAAN ANTIBIOTIKA PADA PASIEN PNEUMONIA KOMUNITAS DI INSTALASI RAWAT INAP RSPAD GATOT SUBROTO. *Maj Farm dan Farmakol*. 2021;25(April):1–6.
 20. Först G, de With K, Weber N, Borde J, Querbach C, Kleideiter J, Seifert C, Hagel S, Ambrosch A, Löbermann M, Schröder P, Steib-Bauert M, Kern WV; ABS-QI Study Group. Först G, de With K, Weber N, Borde J, Querbach C, Kleideiter J, Seifert C, Hagel S, Ambrosch KWAQSG. Validation of adapted daily dose definitions for hospital antibacterial drug use evaluation: a multicentre study. *J Antimicrob Chemother*. 2017;72(10):2931–7.
 21. Syam RA, Karuniawati H. Antibiotic Evaluation Of Hospitalized Pneumonia Patients Using Gyssen or DDD 100 Bed Days or DDD 1000 Patient Days: Review. 2024;21(1):49–64.
 22. Gyssens IC, van den Broek PJ, Kullberg BJ, Hekster Y van der MJ. Optimizing antimicrobial therapy. A method for antimicrobial drug use evaluation. *J Antimicrob Chemother*. 1992;30(5):724–7.
 23. Methodology WCC for DS. Guidelines for ATC classification and DDD assignment 2022 [Internet]. Oslo: WHO Collaborating Centre. 2021. Available from: <https://apps.who.int/whocc/Default.aspx>
 24. Hadi U, Duerink DO, Sri E, Nagelkerke NJ, Werter S, Keuter M, et al. Survey of antibiotic use of individuals visiting public healthcare facilities in Indonesia. 2008;622–9.
 25. Gyssens IC, van den Broek PJ, Kullberg BJ, Hekster Y van der MJ. Optimizing antimicrobial therapy. A method for antimicrobial drug use evaluation. *J Antimicrob Chemother*. 1992;30(5):724–7.
 26. Hasan, M. R., Ansari, M. B., Akter, D., Chowdhury, N. et al. Causes of Death Among Children Under Five in Bangladesh: Evidence from BDHS 2011 and 2017-18 Survey. SSRN. 2023;
 27. Shalini SB, Sudha KS, Bhavani Y, Babu PR. A STUDY ON ACUTE RESPIRATORY TRACT INFECTIONS AMONG CHILDREN AGED 1-5 YEARS , ATTENDING IN A TERTIARY CARE HOSPITAL. 2024;120–4.
 28. Al-kubayasi ASI, Ibraheem AJ, Al-rudaini S. Prevalence and risk factors of acute respiratory infections in children under five : A hospital-based study. 2024;7(2):41–7.
 29. Guma SP, Godman B, Campbell SM, Mahomed O. Determinants of the Empiric Use of Antibiotics by General Practitioners in South Africa : Observational , Analytic , Cross-Sectional Study. 2022;1–20.
 30. Degif KA, Gebrehiwot M, Tadege G, Demoze L, Yitagesu G. Spatial and temporal variation of pneumonia incidence among under - five children in central gondar zone , Northwest Ethiopia , 2013 - 2022. *BMC Pediatr* [Internet]. 2025; Available from: <https://doi.org/10.1186/s12887-025-05550-7>
 31. Rodríguez-contreras FJ, Díaz-lázaro J, Cruz-arnés M, León-vázquez F, Lobón-agúndez MC, Palau-cuevas FJ, et al. Lung Ultrasound Performed by Primary Care Physicians for Clinically Suspected Community-Acquired Pneumonia: A Multicenter Prospective Study. 2022;227–36.
 32. Htun TP, Sun Y, Chua HL, Pang J. Clinical features for diagnosis of pneumonia among adults in primary care setting : A systematic and meta-review. *Sci Rep* [Internet].

- 2019;(November 2018):1-10. Available from: <http://dx.doi.org/10.1038/s41598-019-44145-y>
33. World Health Organization. Pneumonia in Children [Internet]. 2022. Available from: <https://www.who.int/news-room/fact-sheets/detail/pneumonia>
 34. Limato R, Lazarus G, Dernison P, Mudia M, Alamanda M, Nelwan EJ, et al. Optimizing antibiotic use in Indonesia: A systematic review and evidence synthesis to inform opportunities for intervention. *Lancet Reg Heal - Southeast Asia*. 2022;2(6).
 35. Wulan N, Pitasari N, Imba F, Litaay GW. Indonesian Journal of Global Health Research. *Indones J Glob Heal Res*. 2019;2(4):1023-30.
 36. Niazi-Ali S, Bircher J. Broad spectrum antibiotic stewardship by quality improvement methods. *Int J Risk Saf Med*. 2022;33:S35-40.
 37. Aliabadi S, Anyanwu P, Beech E, Jauneikaite E, Wilson P, Hope R, et al. Effect of antibiotic stewardship interventions in primary care on antimicrobial resistance of *Escherichia coli* bacteraemia in England (2013-18): a quasi-experimental, ecological, data linkage study. *Lancet Infect Dis*. 2021;21(12):1689-700.
 38. Mahmudul Islam AFM, Raihan MA, Ahmed KT, Islam MS, Nusrat NA, Hasan MA, et al. Prevalence of inappropriate antibiotic doses among pediatric patients of inpatient, outpatient, and emergency care units in Bangladesh: A cross-sectional study. *PLOS Glob Public Heal* [Internet]. 2024;4(9):1-21. Available from: <http://dx.doi.org/10.1371/journal.pgph.0003657>
 39. Alessa M, Almangour TA, Alhassoun A, Alajaji I, Almangour A, Alsalem A, et al. Adherence to evidence-based guidelines for the management of pneumonia in a tertiary teaching hospital in Riyadh. *Saudi Pharm J* [Internet]. 2023;31(8):101678. Available from: <https://doi.org/10.1016/j.jsps.2023.06.011>
 40. Mangione-Smith R, Zhou C, Robinson JD, Taylor JA, Elliott MN HJ. Communication Practices and Antibiotic Use for Acute Respiratory Tract Infections in Children. *Pediatrics*. 2015;133(3):221-7.
 41. Shapiro DJ, Hall M, Neuman MI, Hersh AL, Cotter JM, Cogen JD, et al. Outpatient Antibiotic Use and Treatment Failure Among Children With Pneumonia. *JAMA Netw open* [Internet]. 2024;7(10):e2441821. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/39470638> <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC11522934>

Bukti korespondensi



Borneo Journal of Pharmacy

Tasks 1

EnglishView Site

OJS

OPEN JOURNAL SYSTEMS

Submissions

Submissions

My Queue 1Archives 2

Help

My Assigned

SearchNew Submission

Filters

Overdue

Incomplete

Stages

Submission

Review

Copyediting

Production

Sections

Editorial Notes

Pharmacology-Toxicology

11327

Hariyani et al.

Analysis of Antibiotic Use in Outpatient Pneumonia Patients at X Blitar Health Center using the Gyssens Method and the Defined Daily Dose

Review

0/001

Assigned reviews completed

Revisions submitted

Open discussions

Last activity recorded on Friday, November 7, 2025.

View Submission

Borneo Journal of Pharmacy

Tasks 0

EnglishView Site

OJS

OPEN JOURNAL SYSTEMS

Submissions

11327 / Hariyani et al. / Analysis of Antibiotic Use in Outpatient Pneumonia Patients at X Blitar Health Center using the Gyssens Method and the Defined

Library

WorkflowPublication

SubmissionReviewCopyeditingProduction

Round 1

Round 1 Status

Waiting for reviewers to be assigned.

Review Discussions

Add discussion

Name	From	Last Reply	Replies	Closed
Important Update Regarding Your Submission to Borneo Journal of Pharmacy - Reviewer Shortage	mohammadrizkifadhilpratama	rina_widi123 2025-11-10 12:07 AM	1	☐

Publikasi Pneumonia fix.docx

by Hesti Rima Hariyani

Submission date: 17-Nov-2025 07:23PM (UTC+0700)

Submission ID: 2818106623

File name: Publikasi_Pneumonia_fix.docx (102.02K)

Word count: 4079

Character count: 24431

Analysis of Antibiotic Use in Outpatient Pneumonia Patients at X Blitar Health Center using the Gyssens Method and the Defined Daily Dose (DDD)

Hesti Rima Hariyani¹

Fauna Herawati^{1*}

Rina Widiyawati²

Nurul Chusna³

¹Department of Clinical Pharmacy,
Faculty of Pharmacy, University of
Surabaya, Surabaya 60293, Indonesia

²Department of Doctoral Programs,
University of STRADA Indonesia,
Indonesia

³Universitas Muhammadiyah
Palangkaraya

*email: fauna@staff.ubaya.ac.id; phone:
+6289650067999

Abstract

Pneumonia is one of the respiratory infections that is still a public health problem and requires appropriate antibiotic therapy. However, irrational use of antibiotics has the potential to increase resistance and worsen patient clinical outcomes. This study aims to analyze antibiotic use in outpatient pneumonia patients at the X Blitar Health Center using the Defined Daily Dose (DDD) and Gyssens methods. This study employed a cross-sectional approach, utilizing secondary data from 109 medical records and prescriptions for pneumonia patients (ICD-10 codes J12-J18) from February 2024 to May 2025. Quantitative analysis was conducted using the DDD/1,000 patients per day method, while qualitative analysis of prescriptions was performed using the Gyssens method. The results showed that Amoxicillin (J01CA04) was the most widely used antibiotic, namely 232.42 DDD/1,000 patients per day, followed by Cefadroxil (87.04 DDD/1,000 patients per day), Ciprofloxacin (18.35 DDD/1,000 patients per day), and Azithromycin (15.29 DDD/1,000 patients per day). Gyssens' analysis revealed that most prescriptions fell into category IIA (33.94%), category IVA (29.36%), and category V (27.52%). Inaccurate dosage and suboptimal antibiotic selection were the leading causes of irrational antibiotic use. Additionally, 30 pneumonia patients were identified who did not receive antibiotics despite having clinical indications for them. The results of this study emphasize the need for rationalization training in therapy, prescription audits, and strengthening the implementation of clinical guidelines in primary care facilities.



Pneumonia
Antibiotics
DDD

INTRODUCTION

Health centers

Antibiotic resistance has become a serious threat to public health worldwide. The World Health Organization (WHO) states that it is one of the top global threats that requires immediate attention^{1,2}. Antimicrobial resistance (AMR) not only threatens the effectiveness of treatment but also worsens the health burden, with projections reaching 10 million deaths per year by 2050 if not controlled^{3,4}.

Inappropriate use of antibiotics, including selecting the type, dose, and duration of administration, is the leading cause of increasing

resistance in pathogenic bacteria that cause serious infections, including pneumonia⁵⁻⁷. Pneumonia itself is the most common respiratory tract infection and is a significant cause of morbidity and mortality in the world⁸⁻¹⁰. Globally, pneumonia causes more than 2.5 million deaths each year, with young children and the elderly being the most vulnerable populations^{3,4}. Thus, pneumonia is the primary focus of controlling the irrational use of antibiotics^{11,12}.

Indonesia, especially at the health center level, the main gateway for primary health care services, has special challenges in handling pneumonia cases. Based on data from the Ministry of Health of the Republic of Indonesia, pneumonia is among the five most common diseases. The number of visits continues to increase every

Received: Month Year

Accepted: Month Year

Published: Month Year

© year The Authors. Published by Institute for Research and Community Services Universitas Muhammadiyah Palangkaraya. This is an open access article under the terms of the Creative Commons Attribution-ShareAlike (CC BY-SA) 4.0 International License. <https://doi.org/10.30605/bjop.vixx.xcc>

year^{11,12}. Health centers often face limitations related to diagnostic facilities, variations in the competence of health workers, and high service time pressure^{13,14}. These conditions have the potential to increase suboptimal antibiotic prescriptions both in terms of choosing the wrong type of antibiotic, inappropriate dosage, and inadequate duration of therapy^{15,16}. In addition, the monitoring and evaluation system for antibiotic use has not been appropriately standardized. The lack of an audit and feedback system makes it challenging to supervise prescribing practices, ultimately contributing to increased resistance and wasteful health costs. Therefore, stricter and more measurable guidelines are urgently needed to manage pneumonia cases at the primary care level¹⁷.

Literature review shows that research evaluating antibiotic use in pneumonia in Indonesian health centers is still limited. Most studies focus on inpatient services or secondary hospitals, and the evaluation methods used are generally not comprehensive^{18,19}. The use of internationally standardized antibiotic evaluation methods, such as the Gyssens method to assess the quality of antibiotic use and the Defined Daily Dose (DDD) method to measure the amount of antibiotic consumption, is rarely applied comprehensively, especially at the primary care level^{20,21}.

The Gyssens method is an effective qualitative method for evaluating the quality of antibiotic use based on the criteria of indication, drug selection, dosage, administration interval, and duration of therapy^{3,22}. Meanwhile, quantitative methods such as the Defined Daily Dose (DDD) developed by the WHO Collaborating Centre for Drug Statistics Methodology provide standard units of measurement for comparing antibiotic consumption between health facilities and over time²³. Combining the two provides a comprehensive mapping of antibiotic use volume and quality.

Unfortunately, there has not been much research integrating these two methods in evaluating antibiotic use in pneumonia cases in primary health care facilities in Indonesia. Research by Syam, R.A & Karuniawati, H (2024) shows that a combination of the Gyssens method

and DDD/1,000 patients per day can provide a more comprehensive evaluation of rational antibiotic use programs²¹. Specific data on the characteristics of rational antibiotic use. Specific data on the characteristics of antibiotic use in pneumonia in Indonesian health centers are also still minimal, even though this information is essential for developing targeted intervention strategies²⁴.

With limited data on antibiotic use in pneumonia at the health center level, this study was designed to analyze antibiotic use in pneumonia patients at the health center using a combination of the Gyssens and DDD methods. The Gyssens method was used to analyze the quality of antibiotic use based on indication, drug selection, dosage, administration interval, and duration of therapy. Meanwhile, the DDD/1,000 patients per day method will be used to measure and compare the quantity of antibiotic consumption in a standardized manner. Integrating these two methods is expected to provide a comprehensive picture of antibiotic use patterns, identify areas that need improvement, and provide evidence-based recommendations for optimizing antibiotic use in pneumonia cases at the health center. The results of this study can be the basis for developing an antimicrobial stewardship program based on the conditions of primary health care in Indonesia.

MATERIALS AND METHODS

Materials

This study employed a cross-sectional design, combining both quantitative and qualitative approaches, to analyze antibiotic use among pneumonia patients at community health centers. Ethical approval was obtained from the Institutional Ethics Committee of the University of Surabaya under number 650/KE/VII/2025.

The research was conducted at Community Health Center X, located in the Blitar area, from July to August 2025. Data were collected from the medical records of patients diagnosed with pneumonia (ICD-10 codes J12-J18) covering the period from February 2024 to May 2025. The site was selected purposively because Community

Health Center X maintains complete and well-documented medical records.

This study's population was all patients with respiratory tract infections treated at the Community Health Center X. The study sample was patients diagnosed with pneumonia (ICD-10 J12-J18), with inclusion criteria being complete medical records and exclusion criteria being referred without prior treatment. The sampling technique used was total sampling for all cases that met the inclusion and exclusion criteria.

The research material, secondary data obtained from the medical records of pneumonia patients, includes patient demographic data, complete diagnosis, antibiotic type, dose, administration frequency, and therapy duration. Data were collected using a simple data collection sheet to calculate DDD/1,000 patients per day and the Gyssens test.

Methods

Two methods were used in this study: the WHO Defined Daily Dose (DDD) method as a quantitative approach and the Gyssens method as a qualitative analysis tool based on prescription accuracy. DDD is useful for comparing antibiotic consumption levels between populations, while Gyssens allows classification based on clinical parameters, including indications, doses, duration, and effectiveness.

WHO Collaborating Centre for Drug Statistics Methodology (2022) and Gyssens et al. (1992) have stated that the combination of the two methods can provide a comprehensive picture of the volume and quality of antibiotic use^{23,25}.

Analysis of the quantity of antibiotic use using the DDD method established by WHO was carried out using the formula:

$$\frac{DDD}{1000} \text{ patients per day} = \frac{\text{Total drug (gram)} \times 1.000}{DDD \text{ WHO (gram)} \times \text{Total Patient}}$$

Description: Total drug = amount of antibiotic use for 1 month (grams); WHO DDD is a standard that refers to the ATC/DDD guidelines; The number 1,000 indicates 1,000 outpatients; Total patients is the total number of patients with pneumonia served by health center X.

Analysis of the quality of antibiotic use was conducted using the Gyssens method which classifies antibiotic use into several categories including category 0 (appropriate use); category I (improper use of time); category IIA (inappropriate use of dose); category IIB (improper use of interval); category IIC (improper use of route); category IIIA (use of antibiotics for too long); category IIIB (use of antibiotics for too short); category IVA (other antibiotics are more effective); category IVB (other antibiotics are safer); category IVC (other antibiotics are cheaper); category IVD (there are other antibiotics with a narrower spectrum); category V (no indication); category VI (incomplete data).

RESULTS AND DISCUSSION

Table I shows the distribution of pneumonia patient characteristics based on age group and gender. The toddler age group (12-59 months) was the most dominant group, at 37.78%, followed by adults (20-59 years) at 25.69% and older people (> 60 years) at 13.76%. These results indicate that pneumonia is still the primary infectious disease that attacks vulnerable age groups, especially young children and the elderly, who have immature immune systems or have experienced decreased immune function. This finding is supported by the WHO report (2023) and research by Troeger et al. (2018), which states that pneumonia is the leading cause of death in toddlers and infectious complications in the elderly in developing countries^{3,25}.

Physiologically, the immune system of toddlers (<5 years) is not fully developed, so they have a lower ability to fight respiratory tract infections such as pneumonia. In addition, children have smaller airway diameters than adults, which causes increased airflow resistance and makes it easier for mucus to block when an infection occurs²⁶. This condition is exacerbated by malnutrition, exposure to indoor air pollution, and lack of exclusive breastfeeding. Studies by Shalini et al. (2024) and Al-Khubayasi et al. (2023) showed that most cases of pneumonia in toddlers were associated with a lack of good nutritional status, low immunization status, and crowded living environments^{27,28}.

The dominance of male patients (55.05%) shown in Table I also aligns with a study in South Africa by Guma et al. (2022), which noted a higher prevalence of pneumonia in males than females²⁹. Biologically, this can be explained by hormonal differences that affect the immune system. Estrogen hormones in women are known to protect against infection by increasing B cell activation and antibody production, while testosterone tends to decrease cellular immune responses. In addition, boys have a higher tendency towards exploratory behavior, which increases exposure to infectious agents^{26,30}.

In addition to biological factors, behavioral differences also contribute to the high incidence of pneumonia in male anal. Boys tend to have higher physical activity, often play outdoors, and are less supervised than girls, which can increase the possibility of exposure to infectious agents from the environment²⁵.

The diagnosis of pneumonia in these patients was dominated by J12.9 viral pneumonia unspecified (32.11%), J16 pneumonia due to other infectious organisms not elsewhere classified (25.69%), and pneumonia unspecified (20.18%), as

seen in Table I. The high number of nonspecific diagnoses reflects the limitations in supporting examinations at health centers. This is supported by a multicenter study in 12 primary clinics conducted by Rodriques-Contreras et al. (2022), which found that point-of-care lung ultrasound (POCUS) had a sensitivity of 87.8% but a specificity of only 58.5% compared to X-ray³¹. In addition, a meta-review conducted by Htun et al. (2019) in adults showed that symptoms such as temperature ≥ 38 oC and respiratory rate ≥ 20 times per minute had a moderately favorable likelihood ratio (LR + 3.2 - 3.5), but were clinically insufficient for diagnosis without imaging or biomarker confirmation³². These studies indicate that clinical diagnosis alone is no less accurate.

Limitations in diagnostic tests cause health workers to use non-specific ICD-10 codes. Etiological identification is essential for determining the need for antibiotics, especially to differentiate viral and bacterial pneumonia. WHO (2023) also emphasized that over-diagnosing bacterial pneumonia in viral cases contributes to irrational antibiotic use³³.

Table I. Distribution of Patient Characteristics

Characteristics		Frequency (n = 109)	Percentage (%)
Age			
Baby	(0 - 11 months)	8	7,34
Toddler	(12 - 59 months)	39	35,78
Child	(5 - 9 years)	26	23,85
Teenager	(10 - 19 years)	5	4,59
Mature	(20 - 59 years)	21	19,27
Elderly	(≥ 60 years)	10	9,17
Gender			
Female		49	44,95
Male		60	55,05
Diagnosis			
J12	Viral pneumonia	3	2,75
J12.2	Parainfluenza virus pneumonia	1	0,92
J12.9	Viral pneumonia, unspecified	35	32,11
J13	Pneumonia due to Streptococcus pneumoniae	1	0,92
J15	Bacterial pneumonia, not elsewhere classified	0	0,00
15.8	Other bacterial pneumonia	2	1,83
15.9	Bacterial pneumonia, unspecified	1	0,92
J16	Pneumonia due to other infectious organisms, not elsewhere classified	28	25,69
J18	Pneumonia, organism unspecified	16	14,68
18.9	Pneumonia, unspecified	22	20,18

Amoxicillin was the most widely used antibiotic in the treatment of pneumonia in this study, with a consumption value of 232.42 DDD/1,000 patients per day (Table II). The figure shows that Amoxicillin contributed 65.82% of the total antibiotic consumption, according to WHO recommendations and national guidelines as the first line of treatment for community-acquired pneumonia. This is in line with the study of Limato et al. (2022), which stated that amoxicillin is the most widely used antibiotic for the treatment of outpatient pneumonia, and is reinforced by the study of Pitasari et al. (2025) at the Khomba Jayapura Health Center, which also showed the

dominance of amoxicillin use in the treatment of pneumonia^{34,35}.

Lower use of Azithromycin and Ciprofloxacin suggests a reduction in broad-spectrum antibiotics, which aligns with antimicrobial stewardship policies. Stewardship programmes in primary care in Tameside and Glossop also reduced the use of broad-spectrum antibiotics by 10.6% over the period 2019–2020³⁶. Similarly, a policy evaluation in England also showed a 24% reduction in fluoroquinolones, including ciprofloxacin, following a national intervention³⁷.

Table II. Results of Analysis of Antibiotic Use Based on DDD

No	ATC Code	Generic Name	Total Grams/DDD	DDD/1,000 patient per day	Percentage	Total Patients
1	J01CA04	Amoxicillin	25,33	232,42	65,82	109
2	J01DB05	Cefadroxil	9,49	87,04	24,65	
3	J01MA02	Ciprofloxacin	2,00	18,35	5,20	
4	J01FA10	Azitromicin	1,67	15,29	4,33	
Total			38,49	353,10	100,00	

A similar survey conducted by Kurniawati et al. (2021) showed that dosage errors were dominant in prescribing antibiotics for ARI in primary care facilities¹⁸. A study in Bangladesh also reported that 56.8% of pediatric prescriptions contained inappropriate antibiotic doses, either overdose or underdose³⁸. As many as 29.36% of prescriptions were in the VIA category (Table III), where the antibiotic chosen was not the most effective option. This indicates a lack of clinical information updates in primary care physician practices. Similar conditions were also seen in hospitals, where in antibiotic selection, 50% of patients received antibiotics that were not according to guidelines³⁹.

In Gyssens' analysis, there were 30 cases (27.52%) that fell into category V, where the patient was diagnosed with pneumonia, but was not given antibiotics at all, even though clinically there were indications that they required antibiotic therapy. This indicates the potential for under-prescribing, where antibiotics should have been given but were not. Some possible causes include health workers

assessing that the pneumonia suffered was mild or caused by a virus (although the diagnosis did not state that a virus caused the pneumonia), lack of clarity in clinical classification and no support for laboratory or radiological examinations that caused doubt in making therapeutic decisions, errors in administrative factors (errors when choosing a diagnosis without intention)¹⁶.

This phenomenon differs from the general trend in primary care, which more often shows overprescribing. Studies by Mangione-Smith et al. (2015) and Shapiro et al. (2024) state that in some situations, such errors can also occur in the form of not providing therapy even though there is a strong indication to offer it^{40,41}. This may indicate the prescriber's caution in giving antibiotics to prevent resistance, but it is not accompanied by strengthening the correct diagnosis, which can hurt patient recovery. Therefore, it is essential to enhance the clinical decision-making support system and ensure that guidelines are easily accessible and that socialized care is socialized when new guidelines exist.

Table III. Results of Gyssens' Analysis

Gyssens's Criterion		Frequency (n = 109)	Percentage (%)
Category 0	(correct)	7	6,42
Category I	(not on time)	0	0,00
Category IIA	(not on dose)	37	33,94
Category IIB	(not on interval)	0	0,00
Category IIC	(not on route)	0	0,00
Category IIIA	(used too long)	0	0,00
Category IIIB	(too short a time)	0	0,00
Category IVA	(used when too short)	32	29,36
Category IVB	(other safer antibiotics)	0	0,00
Category IVC	(other cheaper antibiotics)	0	0,00
Category IVD	(other narrow-spectrum antibiotics)	3	2,75
Category V	(no indication)	30	27,52
Category VI	(incomplete data)	0	0,00
Total		109	100

CONCLUSION

This study shows that the use of antibiotics in outpatient pneumonia patients at Puskesmas X Blitar is dominated by Amoxicillin (232.42 DDD/1,000 patients per day), followed by Cefadroxil, Ciprofloxacin, and Azithromycin. According to Gyssens' analysis, most antibiotic use falls into category IIA (inappropriate dose) and IVA (less effective antibiotic selection). There were also cases where patients diagnosed with pneumonia were not given antibiotics (category V). These results indicate the need for increased compliance with antibiotic therapy guidelines and dose rationalization training. Further research is recommended to evaluate the effectiveness of audit and feedback-based interventions and diagnostic aids in primary care.

ACKNOWLEDGMENT

The author would like to thank the Head of Puskesmas X Blitar and all staff who have given permission and supported the data collection process. Gratitude is also expressed to the Health Office for the administrative support provided. Special appreciation is given to the academic supervisor and proofreader who have helped perfect the contents of this paper. The author also

appreciates the assistance from all parties, which, although the author cannot mention one by one, have helped the smooth running of this research.

Authors' Contribution

Conflict of Interest

The author declares that no financial, personal, or institutional conflict of interest that could influence this research's implementation or results. This research was conducted independently without commercial sponsorship, pharmaceutical industry support, or funding from other external parties. The source of funding came entirely from the author's expenses, without intervention from any party in the planning, data collection, analysis, and writing of the manuscript. The author had full access to all research data and guarantees that no external sponsors or institutions were involved in the interpretation of the data or the decision to publish the results. Thus, the entire content and conclusions result from independent thinking and analysis free from external bias.

REFERENCES

1. World Health Organization. Ten threats to global health in 2019 [Internet]. Geneva: WHO Press. 2019. Available from:

- <https://www.commonwealthnurses.org/the-commonwealthnurse/Documents/Tenthreatstoglobalhealth.pdf>
2. Walsh TR, Gales AC, Laxminarayan R, Dodd PC. Antimicrobial Resistance: Addressing a Global Threat to Humanity. *PLoS Med* [Internet]. 2023;20(7 July):12–5. Available from: <http://dx.doi.org/10.1371/journal.pmed.1004264>
 3. World Health Organization. Global antimicrobial resistance and use surveillance system (GLASS) report. WHO Publ [Internet]. 2023; Available from: <https://www.who.int/publications/i/item/9789240062702>
 4. Murray CJ, Ikuta KS, Sharara F, Swetschinski L, Robles Aguilar G, Gray A, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet*. 2022;399(10325):629–55.
 5. Dadgostar P. Antimicrobial resistance: Implications and costs. *Infect Drug Resist*. 2019;12::3903–3910.
 6. Sartelli M, Barie PS, Coccolini F, Abbas M, Abbo LM, Abdulkhalilova GK, et al. Ten golden rules for optimal antibiotic use in hospital settings: the WARNING call to action. *World J Emerg Surg*. 2023;18(1):1–35.
 7. Mo Y, Oonsivilai M, Lim C, Niehus R, Cooper BS. Implications of reducing antibiotic treatment duration for antimicrobial resistance in hospital settings: A modelling study and meta-analysis. *PLoS Med* [Internet]. 2023;20(6 June):1–20. Available from: <http://dx.doi.org/10.1371/journal.pmed.1004013>
 8. Jain S, Williams DJ, Arnold SR, Ampofo K, Bramley AM, Reed C, Stockmann C, Anderson EJ, Grijalva CG, Self WH, Zhu Y, Patel A, Hymas W, Chappell JD, Kaufman RA, Kan JH, Dansie D, Lenny N, Hillyard DR, Haynes LM, Levine M, Lindstrom S, Winchell JM, Katz JM, FLCEST. Community-acquired pneumonia requiring hospitalization among U.S. children. *N Engl J Med*. 2015;372(9):835–45.
 9. Cilloniz C, Dela Cruz CS, Dy-Agra G, Pagcatipunan RS. World Pneumonia Day 2024: Fighting Pneumonia and Antimicrobial Resistance. *Am J Respir Crit Care Med*. 2024;210(11):1283–5.
 10. Ginsburg AS, Duncan K, Klugman KP, Srikantiah P. Access to antibiotics for pneumonia and sepsis in LMICs. *Lancet Glob Heal* [Internet]. 2024;12(12):e1928–9. Available from: [http://dx.doi.org/10.1016/S2214-109X\(24\)00418-2](http://dx.doi.org/10.1016/S2214-109X(24)00418-2)
 11. Kementerian Kesehatan Republik Indonesia. Profil Kesehatan Indonesia Tahun 2020 [Internet]. Jakarta: Kemenkes RI. 2021. Available from: [file:///C:/Users/hpryz/Downloads/Profil-Kesehatan-Indonesia-2020 \(1\).pdf](file:///C:/Users/hpryz/Downloads/Profil-Kesehatan-Indonesia-2020%20(1).pdf)
 12. Epidemiolog.id. ISPA dan Pneumonia: Masalah Kesehatan pada Balita di Indonesia. [Internet]. 2025. Available from: https://www.epidemiolog.id/ispa-dan-pneumonia-masalah-kesehatan-pada-balita-di-indonesia/?utm_source=chatgpt.com
 13. Haryanti F, Laksanawati IS, Arguni E, Widyarningsih SA, Ainun NA, Rastiwi N. Evaluation of the Implementation of Integrated Management of Childhood Illness in Special Region of Yogyakarta Province, Indonesia. *Open Access Maced J Med Sci*. 2022;10(B):570–5.
 14. Wahyuni, Sri; Ferial L. Pemeriksaan Puskesmas di Daerah Terpencil terhadap Fasilitas Kesehatan. *J BAJA Heal Sci*. 2023;3(01):91–108.
 15. Bellatasie R, Oktavia S, Mawarni KE, Adriani S, Wiliantari S. Evaluation of Antibiotic Prescription in Community-Acquired Pneumonia Patients with Gyssens Method. 2023;8(4):2057–62.
 16. Sulis G, Adam P, Nafade V, Gore G, Daniels B, Daftary A, et al. Antibiotic prescription practices in primary care in low- And middle-income countries: A systematic review and meta-analysis. *PLoS Med* [Internet]. 2020;17(6):1–20. Available from: <http://dx.doi.org/10.1371/journal.pmed.1003139>
 17. Guisado-Gil AB, Mejias-Trueba, M.; Peñalva

- G., Aguilar-Guisado, M.; Molina J., Gimeno, A.; Álvarez-Marín R., Praena, J.; Bueno, C.; Lepe JA. et al. Antimicrobial Stewardship in the Emergency Department Observation Unit: Definition of a New Indicator and Evaluation of Antimicrobial Use and Clinical Outcomes. *Antibiotics*. 2024;13(4):356.
18. Kurniawan, Kris; Nuryastuti, Titik; Puspitasari I. Evaluasi Penggunaan Antibiotik Empirik Terhadap Outcome Klinik dan Gambaran Antibiotikogram Pada Pasien ISPA di Puskesmas Jetis Yogyakarta. *Maj Farm*. 2021;17(3):256-64.
 19. Hardiana, I; Laksmiawati, Dian Ratih; Ramadaniati, Hesti Utama; Sutarno S. EVALUASI PENGGUNAAN ANTIBIOTIKA PADA PASIEN PNEUMONIA KOMUNITAS DI INSTALASI RAWAT INAP RSPAD GATOT SUBROTO. *Maj Farm dan Farmakol*. 2021;25(April):1-6.
 20. Först G, de With K, Weber N, Borde J, Querbach C, Kleideiter J, Seifert C, Hagel S, Ambrosch A, Löbermann M, Schröder P, Steib-Bauert M, Kern WV; ABS-QI Study Group. Först G, de With K, Weber N, Borde J, Querbach C, Kleideiter J, Seifert C, Hagel S, Ambrosch KWAQSG. Validation of adapted daily dose definitions for hospital antibacterial drug use evaluation: a multicentre study. *J Antimicrob Chemother*. 2017;72(10):2931-7.
 21. Syam RA, Karuniawati H. Antibiotic Evaluation Of Hospitalized Pneumonia Patients Using Gyssen or DDD 100 Bed Days or DDD 1000 Patient Days: Review. 2024;21(1):49-64.
 22. Gyssens IC, van den Broek PJ, Kullberg BJ, Hekster Y van der MJ. Optimizing antimicrobial therapy. A method for antimicrobial drug use evaluation. *J Antimicrob Chemother*. 1992;30(5):724-7.
 23. Methodology WCC for DS. Guidelines for ATC classification and DDD assignment 2022 [Internet]. Oslo: WHO Collaborating Centre. 2021. Available from: <https://apps.who.int/whocc/Default.aspx>
 24. Hadi U, Duerink DO, Sri E, Nagelkerke NJ, Werter S, Keuter M, et al. Survey of antibiotic use of individuals visiting public healthcare facilities in Indonesia. 2008;622-9.
 25. Gyssens IC, van den Broek PJ, Kullberg BJ, Hekster Y van der MJ. Optimizing antimicrobial therapy. A method for antimicrobial drug use evaluation. *J Antimicrob Chemother*. 1992;30(5):724-7.
 26. Hasan, M. R., Ansari, M. B., Akter, D., Chowdhury, N. et al. Causes of Death Among Children Under Five in Bangladesh: Evidence from BDHS 2011 and 2017-18 Survey. *SSRN*. 2023;
 27. Shalini SB, Sudha KS, Bhavani Y, Babu PR. A STUDY ON ACUTE RESPIRATORY TRACT INFECTIONS AMONG CHILDREN AGED 1-5 YEARS , ATTENDING IN A TERTIARY CARE HOSPITAL. 2024;120-4.
 28. Al-kubayasi ASI, Ibraheem AJ, Al-rudaini S. Prevalence and risk factors of acute respiratory infections in children under five: A hospital-based study. 2024;7(2):41-7.
 29. Guma SP, Godman B, Campbell SM, Mahomed O. Determinants of the Empiric Use of Antibiotics by General Practitioners in South Africa: Observational , Analytic , Cross-Sectional Study. 2022;1-20.
 30. Degif KA, Gebrehiwot M, Tadege G, Demoze L, Yitagesu G. Spatial and temporal variation of pneumonia incidence among under - five children in central gondar zone , Northwest Ethiopia , 2013 - 2022. *BMC Pediatr* [Internet]. 2025; Available from: <https://doi.org/10.1186/s12887-025-05550-7>
 31. Rodríguez-contreras FJ, Díaz-lázaro J, Cruz-arnés M, León-vázquez F, Lobón-agúndez MC, Palau-cuevas FJ, et al. Lung Ultrasound Performed by Primary Care Physicians for Clinically Suspected Community-Acquired Pneumonia: A Multicenter Prospective Study. 2022;227-36.
 32. Htun TP, Sun Y, Chua HL, Pang J. Clinical features for diagnosis of pneumonia among adults in primary care setting: A systematic and meta-review. *Sci Rep* [Internet]. 2019;(November 2018):1-10. Available from: <http://dx.doi.org/10.1038/s41598-019-44145-y>
 33. World Health Organization. Pneumonia in Children [Internet]. 2022. Available from:

- <https://www.who.int/news-room/fact-sheets/detail/pneumonia>
34. Limato R, Lazarus G, Dernison P, Mudia M, Alamanda M, Nelwan EJ, et al. Optimizing antibiotic use in Indonesia: A systematic review and evidence synthesis to inform opportunities for intervention. *Lancet Reg Heal - Southeast Asia*. 2022;2(6).
 35. Wulan N, Pitasari N, Imba F, Litaay GW. Indonesian Journal of Global Health Research. *Indones J Glob Heal Res*. 2019;2(4):1023–30.
 36. Niazi-Ali S, Bircher J. Broad spectrum antibiotic stewardship by quality improvement methods. *Int J Risk Saf Med*. 2022;33:35–40.
 37. Aliabadi S, Anyanwu P, Beech E, Jauneikaite E, Wilson P, Hope R, et al. Effect of antibiotic stewardship interventions in primary care on antimicrobial resistance of *Escherichia coli* bacteraemia in England (2013–18): a quasi-experimental, ecological, data linkage study. *Lancet Infect Dis*. 2021;21(12):1689–700.
 38. Mahmudul Islam AFM, Raihan MA, Ahmed KT, Islam MS, Nusrat NA, Hasan MA, et al. Prevalence of inappropriate antibiotic doses among pediatric patients of inpatient, outpatient, and emergency care units in Bangladesh: A cross-sectional study. *PLOS Glob Public Heal* [Internet]. 2024;4(9):1–21. Available from: <http://dx.doi.org/10.1371/journal.pgph.0003657>
 39. Alessa M, Almangour TA, Alhassoun A, Alajaji I, Almangour A, Alsalem A, et al. Adherence to evidence-based guidelines for the management of pneumonia in a tertiary teaching hospital in Riyadh. *Saudi Pharm J* [Internet]. 2023;31(8):101678. Available from: <https://doi.org/10.1016/j.jsps.2023.06.011>
 40. Mangione-Smith R, Zhou C, Robinson JD, Taylor JA, Elliott MN HJ. Communication Practices and Antibiotic Use for Acute Respiratory Tract Infections in Children. 2015;13(3):221–7.
 41. Shapiro DJ, Hall M, Neuman MI, Hersh AL, Cotter JM, Cogen JD, et al. Outpatient Antibiotic Use and Treatment Failure Among Children With Pneumonia. *JAMA Netw open* [Internet]. 2024;7(10):e2441821. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/39470638> <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC11522934>

ORIGINALITY REPORT

8%

SIMILARITY INDEX

6%

INTERNET SOURCES

5%

PUBLICATIONS

1%

STUDENT PAPERS

PRIMARY SOURCES

1

www.researchgate.net

Internet Source

1%

2

eduvest.greenvest.co.id

Internet Source

1%

3

journals.innovareacademics.in

Internet Source

1%

4

orcid.org

Internet Source

1%

5

nusantarahasajournal.com

Internet Source

1%

6

Abbo, L., A. Casiano-Colon, M. Tysiak, T. M. Hooton, J. Stiles, R. Fagan, N. Gualandi, Z. G. Beldavs, G. Dumyati, M. Kainer, R. Lynfield, M. Maloney, J.-Y. Min, J. Nadle, S. M. Ray, K. Richards, S. Fridkin, S. S. Magill, K. Uganski, K. Bucher, G. R. Deyoung, N. Egwuatu, A. Weise, J. Prusa, L. Dumkow, C. Andrzejewski, K. Shutt, H. Freedy, G. Galang, M. Yassin, S. Doron, N. Mcelroy, S. Salem-Schatz, P. Griswold, D. Pallin, R. Kandel, E. Mchale, N. Simmons, A. Demaria, B. Chironda, J. Powis, C. Hoffmann, E. Sydnor, M. L. Brundige, S. Patel, C. Evans, E. Rightmier, M. Staicu, C. Felsen, E. D. Ashley, G. Dumyati, L. Miller, K. Kahn, S. J. Eells, S. Choi, M. Riva, M. Go-Wheeler, T. Hossain, J. Grein, T. Geide, M. Ignacio, J. C. Thompson, K. Talledo, L. Abbo, L. Ka-Ming, C. Amado, P. Blair, M. Siegel, J. Keiser, M. Haas, B. Knepper, K. Kaucher, K. Shihadeh, J. Sankoff, T. Jenkins, D.

1%

Waters, B. Bryan, D. Evans, N. Kasbekar, J.
O'donnell, T. Dougherty, R. Maniglia, C.
Boedec, C. Edwards, A. Binkley et al. "POSTER
ABSTRACTS", Open Forum Infectious
Diseases, 2014.

Publication

7

journal.ugm.ac.id

Internet Source

1 %

8

Safira Ristanti, Ronald Pratama Adiwinoto,
Rike Andy Wijaya, Saptono Putro. "Antibiotic
Therapy Evaluation of Patients Diagnosed
with Sepsis in ICU of dr. Mohamad
Soewandhie General Hospital based on the
Gyssens Method", Jurnal Kedokteran Meditek,
2025

Publication

1 %

9

Submitted to MGH Institute of Health
Professions

Student Paper

1 %

10

journal2.uad.ac.id

Internet Source

1 %

Exclude quotes On

Exclude matches < 1%

Exclude bibliography On