

Quantity Evaluation of Antibiotics Use in Patients with Lung Infection in The Internal Medicine Ward of Banyumas Regional General Hospital Using The Defined Daily Dose (DDD) Method

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Abstract

Background: Pulmonary infection is one of the leading causes of morbidity and mortality among hospitalized patients. The high incidence of pulmonary infections accompanied by significant morbidity and mortality makes antibiotic use an essential part of patient management. Antibiotic use without appropriate evaluation and monitoring may lead to irrational antibiotic use, which can contribute to the development of antimicrobial resistance. In addition, variations in local bacterial patterns and the absence of locally based antibiotic use guidelines at Banyumas Regional General Hospital indicate the urgency of conducting a quantitative evaluation of antibiotic use. **Objectives:** This study aimed to evaluate antibiotic use among patients with pulmonary infections in the Internal Medicine Ward of Banyumas Regional General Hospital during July–December 2024 using the Defined Daily Dose (DDD) method. **Methods:** This study was a retrospective descriptive observational study using secondary data obtained from medical records of pulmonary infection patients who met the inclusion criteria. Quantitative analysis of antibiotic use was performed using the DDD per 100 patient-days method and Drug Utilization (DU) 90% analysis. **Key findings:** A total of 11 types of antibiotics were used with a total consumption of 97.756 DDD/100 patient-days. Parenteral ceftriaxone was the most frequently used antibiotic, with a value of 44.44 DDD/100 patient-days and the highest percentage in the DU 90% segment. **Conclusions:** Antibiotic use among pulmonary infection patients in the Internal Medicine Ward of Banyumas Regional General Hospital was dominated by watch and reserve group antibiotics, with ceftriaxone being the most frequently used antibiotic. Therefore, continuous evaluation and monitoring of antibiotic use are required to improve rational antibiotic use and reduce the risk of antimicrobial resistance.

Keywords: Antibiotics, Defined Daily Dose, DU 90%, Lung infection, Antibiotic resistance

Introduction

Lung infection is a disease that has become one of the global health issues. This condition can affect various age groups, from infants to the elderly. According to the WHO report, lung infection is one of the most common causes of death, with 3.5 million cases annually. The course of lung infection begins with acute inflammation of the lung tissue causing symptoms such as fever, cough, chest pain, and shortness of breath. According to the Health Office (2023), pneumonia cases in Central Java in 2023 reached 45,765. The mortality rate of pneumonia cases in adults in Indonesia reached 11.3% and became one of the highest mortality rates in Southeast Asia. One of the most common causes of lung infection is the bacterium *Streptococcus pneumoniae* or *Pneumococcus*. Treatment of lung infection is carried out using antibiotics whose use needs to be supervised and evaluated by healthcare professionals.

Antibiotics have a role as therapy for lung infections based on microorganism data and antibiotic susceptibility test results. The use of antibiotics must consider the

frequency, timing, and treatment plan in accordance with the patient's condition. Several studies found that there were 40–62% inappropriate uses of antibiotics for diseases that do not require antibiotics. Excessive administration of antibiotics and use that is not based on proper indications can lead to an increase in antibiotic resistance. Globally in 2019, there were 1.27 million deaths caused by antibiotic resistance or antimicrobial resistance (AMR). Ineffective control of antibiotic use may result in 10 million deaths due to antimicrobial resistance by 2050. The rapid increase in antibiotic resistance cases has become a global health issue and a threat to world health.

Based on bacterial pattern data from the laboratory installation of Banyumas Regional General Hospital, there is a varying pattern of bacterial resistance to antibiotics. This indicates the importance of selecting empirical and definitive antibiotics adjusted to treatment guidelines and local resistance data so that the therapy provided can be effective. Although many studies have been conducted, those studies were carried out in different hospitals with

varying antibiotic control policies and patient conditions. The variation in bacterial resistance patterns to antibiotics at Banyumas Regional General Hospital, the absence of established Antibiotic Use Guidelines (PPAB), and the lack of published studies regarding the evaluation of antibiotic use at Banyumas Regional General Hospital indicate the urgency of evaluating antibiotic use at Banyumas Regional General Hospital.

Drug use evaluation (DUE) can be conducted qualitatively or quantitatively. Qualitative DUE can use the Gyssens method, which is performed to assess the appropriateness of drug use based on drug use criteria according to indications. Quantitative DUE is conducted using the Defined Daily Dose (DDD) method with Drug Use (DU) 90% associated with the Anatomical Therapeutic Chemical (ATC) classification. DDD is a quantitative analysis method standardized by WHO used to describe the average maintenance dose per day of a drug used in adults. DU 90% is a method used to indicate the group of drugs included in the 90% segment of the most frequently used drugs.

Based on the explanation above, the authors are interested in conducting a study on the quantitative evaluation of antibiotic use using the DDD method to describe the quantity of antibiotic use in patients with lung infection in the internal medicine ward of Banyumas Regional General Hospital.

Materials and Methods

This study used a retrospective descriptive method with a cross-sectional approach using secondary data obtained from the medical records of pulmonary infection patients at Banyumas Regional General Hospital. The population of this study consisted of medical records of hospitalized pulmonary infection patients in the Internal Medicine Ward of Banyumas Regional General Hospital who received antibiotic prescriptions. The sample of this study was pulmonary infection patients in the Internal Medicine Ward of Banyumas Regional General Hospital who received antibiotic treatment during the period of July 1 – December 31, 2024, and met the inclusion and exclusion criteria. The sampling technique used was consecutive sampling with a total sample size of 37.

Tools and Materials

The data collection instrument used was a survey sheet containing medical information of pulmonary infection patients, including demographic data, clinical data, and antibiotic therapy data.

Research Procedure

The study was conducted from September 2025 to October 2025. The study began with data collection at the medical records department of Banyumas Regional General Hospital. Subsequently, identification of the inclusion and exclusion criteria was carried out on the obtained samples. Data were collected until the required sample size was fulfilled, then processed and analyzed to determine antibiotic use in pulmonary infection patients at Banyumas Regional General Hospital.

Data Analysis

The collected data were analyzed univariately. Univariate analysis showed the distribution of pulmonary infection patient characteristics, quantitative evaluation of antibiotic use, and bacterial culture data presented in the form of distribution tables. The distribution data of research subject characteristics included sex, age, length of hospitalization, diagnosis, and antibiotic use profile. Quantitative evaluation data of antibiotic use included the calculation data of antibiotic DDD/100 patient-days of antibiotic use, while the distribution of bacterial culture data included bacterial culture results in patients.

Results and Discussion

Analysis was carried out on 37 samples that met the inclusion and exclusion criteria. There were 37 samples in this study, with a gender distribution, namely 63.16% males and 36.84% females. The majority of patients were in the elderly age group, with 52.63% aged >65 years, 26.32% aged 56-65 years. The age group of 46 - 55 years made up 10.53% of patients. Only a small percentage are ≤ 35 years old, with a percentage of 2.63% in the age range of 18 - 25 years and 26 - 35 years respectively. The length of patient hospitalization was dominated by the number of treatment days ≤ 7 days, which was 73.68%. The diagnosis of patients was dominated by Bronchopneumonia as many as 22 patients with a percentage of 57.89%. The profile of antibiotic use in patients with lung infections in the internal medicine ward of Banyumas Hospital was obtained as ceftriaxone intravenous injection route with a percentage of 41.38%. Evaluation of antibiotic use using the DDD method within 100 days of hospitalization in 37 patients with lung infection showed parenteral ceftriaxone to be antibiotic with the highest DDD value of 44.44. Meanwhile, the lowest DDD value of antibiotics is levofloxacin with a DDD value of 0.411. Based on the calculation of the Drug Utilization (DU) segment, antibiotics included in the 90% DU are parenteral ceftriaxone, parenteral meropenem, parenteral levofloxacin, and parenteral ceftazidim.

Lung infection is a disease that is one of the health issues in the world. This condition can be experienced by various age groups from infants to the elderly [29]. Based on the results of the study, the most inpatient lung infection patients were adult patients with male sex with a percentage of 63.16%. Gender is one of the factors that affect the formation of an immune response, resulting in a difference in the prevalence of infection. The hormone 17-β estradiol possessed by women functions to stabilize and increase the immune reaction when infection occurs by releasing inflammatory mediators such as TNF, IL-2, IL-4, IL-6, IL8, and IFN-γ [7]. A study conducted by Sabtersi et al. [25] states that the difference in prevalence between males and females is also influenced by the genetic aspect, namely the XX chromosome possessed by females. The X chromosome has a role as a microRNA that functions in the human immune system. In addition, age is one of the risk factors for the occurrence of lung infections. As humans age, humans experience a decrease in lung function which leads to a decrease in the elasticity of the chest wall, and a decrease in the activity of cleaning

vibrating hairs on the mucous membranes. This causes microorganisms to easily enter and infect the lungs [2]. This is in line with the results of the study which showed that the highest number of patients was found in the age group of >65 years with a percentage of 52.63%, followed by patients aged 56-65 years with a percentage of 26.31%. A study conducted by Fagerli et al. [6] states that the annual incidence of hospitalized pneumonia at the age of ≥ 65 years shows a figure three times higher compared to the younger age group.

Length of Stay (LoS) is the time a patient stays in the hospital during treatment from the time the patient is admitted to the hospital (MRS) to the patient is discharged (KRS) [28]. This study showed that the length of hospitalization for lung infection patients was ≤ 7 days with a percentage of 73.68%. The length of treatment for lung infection patients is individual based on the patient's response to treatment and comorbid conditions [13]. Based on the guidelines of the American Thoracic Society [12], the duration of antibiotic administration in pneumonia patients is 5-7 days.

The antibiotic use profile in this study showed that ceftriaxone was the most widely used antibiotic with 24 prescriptions (41.38%). The results of this study are in line with research conducted by Hadiq et al. [9] which shows that ceftriaxone is the most widely used antibiotic in adult pneumonia patients. Ceftriaxone is widely chosen by hospitals as the first-line therapy for the treatment of patients with lung infections because it has high effectiveness, and great eradication ability, so that patients have a shorter length of hospitalization. The half-life of ceftriaxone is longer than other cephalosporin antibiotics, namely, ± 8 hours, so the administration is enough twice with a 1-gram dose regimen [1].

Evaluation of antibiotic use in hospitals is one of the efforts to control the use of antibiotics to reduce the rate of resistance [8]. Quantitative assessment of antibiotic use was carried out using the DDD/100-day hospitalization method that has been recommended by WHO [30]. The increasing total value of DDD/100 days of hospitalization can be interpreted as having high antibiotic use so that it can be an indication of irrational drug use [10]. Based on the results of this study, 11 variations of antibiotic use were obtained in patients with lung infections in the internal medicine ward of Banyumas Hospital for the period of July - December 2024 with a total DDD of 97,756. This value can be interpreted that in that period on average in 100 days of hospitalization, there are 97.756% of lung infection patients who received daily doses of antibiotics [31]. The use of antibiotics with the largest order was parenteral ceftriaxone 44.44 DDD/100, parenteral meropenem 23.18 DDD/100, parenteral levofloxacin 14.40 DDD/100, parenteral ceftazidim 7.92 DDD/100, oral azithromycin 2,057, parenteral moxifloxacin 1,234 DDD/100, oral ciprofloxacin 1,234 DDD/100, parenteral ciprofloxacin 1,234 DDD/100, metronidazole and parenteral gentamycin 0.823 DDD/100, and oral levofloxacin 0.411 DDD/100. The highest antibiotic use in this study was parenteral ceftriaxone with a value of 44.44 DDD/100 days of hospitalization. These results are in line with research conducted by Ningrum [20] and Zahra [31] that the

antibiotic ceftriaxone is the most commonly used treatment in pneumonia patients.

Ceftriaxone is an antibiotic used as an empirical firstline for inpatient pneumonia patients based on PDPI recommendations with mild and severe inpatient conditions [22]. Empirical antibiotic administration was given less than 8 hours after the patient was admitted to the hospital, especially in potentially life-threatening patient conditions. This is done because the culture examination for germ identification and sensitivity tests takes several days before the results are available [26]. The high DDD value of ceftriaxone in this study was related to the proportion of lung infection patients who received ceftriaxone as empirical therapy, namely 24 out of 38 patients. Although the use of ceftriaxone as an empirical therapy is in accordance with the guidelines, the high value of DDD should also be considered, especially if the use of such broad-spectrum antibiotics is maintained without further evaluation. The use of broad-spectrum antibiotics as empirical therapy must be de-escalated. De-escalation aims to focus antibiotic spectrum therapy according to culture outcomes to lower the potential for antibiotic resistance [15].

The DU 90% method is a method that shows the grouping of drugs in the 90% segment which means the most widely used antibiotics and antibiotics grouped into the 10% segment that shows the least antibiotics used in prescription [2]. The purpose of the 90% DU method is to determine the focus of evaluation, use control and drug procurement planning [19]. The types of antibiotics that are classified in the 90% segment in this study are parenteral ceftriaxone 45.46%, parenteral meropenem 23.71%, parenteral levofloxacin 14.73%, parenteral ceftazidim 8.10%.

Based on the AWaRe classification published by WHO, ceftriaxone, ceftazidime, and levofloxacin are included in the watch group [14]. Meanwhile, meropenem is an antibiotic that is classified as a reserve group of the AWaRe category that has been determined by WHO. WHO has set a target of using antibiotics for the access group as $\geq 60\%$ as an effort to control antibiotic resistance [32]. However, in this study, the results of the DU segment of 90% showed that no antibiotics were found in the access group. The dominance of the DU segment of 90% was in the watch and reserve groups, which shows that the use of antibiotics in this study used more broad-spectrum antibiotics. According to Gazali et al. [8] antibiotics in the watch group that occupy the DU segment of 90% have a high risk of resistance because they are related to the use of high-spectrum broad-spectrum antibiotics. In addition, the presence of meropenem as a reserve group antibiotic in the DU segment of 90% with a percentage of 23.71% indicates the use of last-line antibiotics in relatively large quantities. These findings indicate the need for further evaluation of the reasons for antibiotic use based on clinical indications, as well as the appropriateness of meropenem selection in patients with lung infection. This evaluation is important to ensure that the use of last-line antibiotics remains selective and in accordance with the principles of rational antibiotic use.

Table 1. Distribution of Research Subject Characteristics

Features		Quantity	Presentase
Type	Male	24	63,16%
Sex	Women	14	36,84%
Age	18-25 years old	1	2,63%
	26-35 years old	1	2,63%
	36-45 years old	2	5,26%
	46-55 years old	4	10,53%
	56-65 years old	10	26,32%
	> 65 years old	20	52,63%
Length of Stay	≤ 7 days	28	73,68%
	> 7 days	10	26,32%
Antibiotic Use Profile	Ceftriaxone (IV)	24	41,38%
	Meropenem (IV)	11	18,97%
	Ceftazidim (IV)	9	15,52%
	Levofloxacin (IV)	6	10,34%
	Azitromicin (Tab)	2	3,45%
	Levofloxacin (Tab)	1	1,72%
	Gentamicin (IV)	1	1,72%
	Moxifloxacin (IV)	1	1,72%
	Ciprofloxacin (Tab)	1	1,72%

Table 2. Quantity of Antibiotic Use with DDD/100 days of hospitalization

ATC Code	Antibiotics	Route	DDD WHO	Jml AB used (grams)	LoS	DDD/ 100 Hospitalization Day	DU90% (DDD AB/DDD Total x 100%)	Segmen
J01DD04	Ceftriaxone	P	2	216 gr		44,44	45,46%	
J01DH02	Meropenem	P	3	169gr		23,18	23,71%	OF 90%
J01MA12	Levofloxacin	P	0,5	17,5gr		14,40	14,73%	
J01DD02	Ceftazidim	P	4	80gr		7,92	8,10%	
J01FA10	Azithromycin	O	0,3	1.5gr	243	2,057	2,10%	OF 10%
J01MA14	Moxifloxacin	P	0,4	1.2gr		1,234	1,26%	
J01MA02	Ciprofloxacin	O	1	3gr		1,234	1,26%	
J01MA02	Ciprofloxacin	P	0,8	4gr		1,234	1,26%	
J01XD01	Metronidazole	P	1,5	3gr		0,823	0,841%	
J01GB03	Gentamism	P	0,24	0,48gr		0,823	0,841%	
J01MA12	Levofloxacin	O	0,5	0.5gr		0,411	0,42%	
TOTAL DDD/100 days of hospitalization throughout AB							97,756	

Conclusion

Quantitative evaluation of the use of antibiotics in patients with lung infections in the Internal Medicine Ward of Banyumas Hospital for the period of July - December 2024 shows that there are 11 types of antibiotics with a total consumption of 97,756DDD/100 days of hospitalization. The dominance of antibiotic use based on DDD value was ceftriaxone intravenous injection route with a DDD of 44.44DDD/100 days of hospitalization. The antibiotics included in the 90% DU were ceftriaxone 45.46%, meropenem 23.71%, levofloxacin 14.73%, and ceftazidim 8,10%., the antihistamine class became the most widely used.

Supplementary Material

None

Author Contributions

AI : Conceptualization, Methodology, Writing-Original Draft. **ES** : Data Curation, Formal Analysis, Visualization. **DUA** : Supervision, Funding Acquisition, Writing- Review & Editing.

Conflict of Interest

The authors have no financial conflicts of interest to declare.

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