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Evaluation of Antibiotic Utilization Patterns in Community-Acquired Pneumonia Inpatients Using ATC/DDD and DU 90% Methods at Taman Husada Bontang Regional General Hospital in 2024

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ABSTRACT

Community-acquired pneumonia (CAP) represents an acute infectious inflammatory condition affecting the lung parenchyma, typically contracted in non-hospital settings. Antibiotic therapy serves as the primary treatment modality for CAP. This investigation employs a dual methodological approach: quantitative assessment through the Defined Daily Dose (DDD) metric and qualitative evaluation utilizing the Drug Utilization 90% (DU 90%) analysis. The study objectives focus on characterizing antibiotic consumption patterns among CAP patients at Taman Husada Bontang Regional General Hospital during 2024, employing both ATC/DDD and DU90% analytical frameworks. This quantitative descriptive research utilized retrospective data collection from medical records of CAP inpatients admitted between January and June 2024. Following comprehensive screening, 83 eligible patient records were included for analysis. Data processing involved descriptive statistical methods with Microsoft Excel for tabular presentation of findings. Demographic analysis revealed a homogeneous age distribution (100% within 18-39 years) with male predominance (59%). Quantitative evaluation identified Ceftriaxone as the most frequently prescribed antibiotic (42.5 DDD/100 treatment days). The DU 90% analysis further delineated the therapeutic landscape, with Ceftriaxone (52.9%), Levofloxacin (23.5%), Azithromycin (11.1%), and Ceftazidime (5.3%) constituting the predominant therapeutic agents.

Keywords: community-acquired pneumonia, antibiotic, defined daily dose, drug utilization 90%

Introduction

Pneumonia is a type of infection marked by the sudden onset of inflammation in the lung tissue, which is often accompanied by fluid buildup in the alveolar spaces (Kresnawati et al., 2021). Community-acquired pneumonia refers to lung

inflammation triggered by infectious agents that are contracted outside hospital environments. The primary cause of CAP is gram-positive bacteria. Research in the United States has identified common pathogens responsible for CAP, including rhinovirus (9%), influenza virus (6%), and Streptococcus pneumoniae (11.9%) (Ramirez, 2024). Meanwhile, studies in Asia report that gram-positive bacteria including Chlamydia pneumoniae (13.4%), Streptococcus pneumoniae (11.9%), and Mycoplasma pneumoniae are among the leading causes. In Indonesia, data indicates that Klebsiella pneumoniae (14%) and Streptococcus pneumoniae (13%) are the most prevalent causative agents (Health Ministry of Indonesia, 2023). According to the Indonesian Health Survey (2023), the prevalence of pneumonia among adults reached 74.7%, with higher incidence rates in rural areas. The provinces with the highest reported cases were Papua Pegunungan (36.6%), Central Papua (25.8%), and East Nusa Tenggara (22.1%). In East Kalimantan, the prevalence was recorded at 7.4% (Health Ministry of Indonesia – BKPK, 2023).

The primary treatment for CAP is the administration of antibiotics, which may act by destroying bacterial cells (bactericidal) or merely inhibiting their multiplication (bacteriostatic). The broad-scale application of antibacterial drugs, however, serves as a major driver for the development of resistant strains. One of the contributing factors to resistance in the community is the excessive use of antibiotics in CAP therapy (Health Ministry of Indonesia, 2021). Evaluation of antibiotic use in pneumonia patients is essential and can be conducted through surveillance of usage patterns, identification of causative microbes, their antibiotic sensitivity, and routine reporting (Astuti & Arfania, 2018). Such evaluations are crucial to monitor and control antibiotic prescribing practices, distribution, and treatment-related costs (Health Ministry of Indonesia, 2017).

Drug utilization evaluations can be conducted qualitatively to assess the appropriateness of use by employing the Drug Utilization 90% analytical framework, and quantitatively using the Defined Daily Doses (DDD) method to measure usage patterns and volumes. The World Health Organization (WHO) has developed a standardized method for evaluating drug use through the DDD approach, which categorizes pharmaceutical products following the Anatomical Therapeutic Chemical taxonomy (WHO, 2024). A high total DDD per 100 treatment days indicates a higher level of antibiotic consumption during that period (Health Ministry of Indonesia, 2015). The DU 90% method can be integrated with the ATC/DDD classification to identify antibiotics with the highest usage in hospital settings and to help minimize negative outcomes from inappropriate use. This method supports rational antibiotic prescribing based on clinical efficacy, microbial sensitivity, the patient's condition, antibiotic spectrum, hospital formulary, and diagnosis. An increase in the number of drugs within the DU 90% segment may reflect reduced selectivity in antibiotic selection (Mahmudah, 2016).

A 2022 investigation at RSD X in Badung Regency employed both DDD/100 treatment days and DU 90% methodologies to analyze antibiotic utilization, evaluating treatment appropriateness in accordance with national formulary guidelines. The research documented 15 antibiotics showing an aggregate consumption rate of 171.85 defined daily doses per 100 treatment days, with

Levofloxacin infusion (79.88) and Ceftriaxone injection (40.52) demonstrating the highest utilization. The DU 90% analysis revealed Levofloxacin infusion (46.51%), Ceftriaxone injection (23.60%), Azithromycin tablets (4.74%), Cefoperazone injection (4.18%), Meropenem injection (4.06%), Ciprofloxacin infusion (3.89%), and Levofloxacin tablets (3.59%) as the most commonly prescribed agents (Prasetya et al., 2023).

Aninditha's 2024 study examining antibiotic prescribing patterns for pneumonia inpatients at a regional referral center (anonymized as Hospital X) in Palembang reported Ceftriaxone (41.41 DDD/100 patient-days), Levofloxacin (24.20), and Azithromycin (22.80) as the most heavily utilized medications. Within the DU 90% segment, the predominant antibiotics were Ceftriaxone (accounting for 36.02% of prescriptions), followed by Levofloxacin, Azithromycin, Cefoperazone, Cefotaxime, Ampicillin, Ceftazidime, and Cefixime.

Currently, no quantitative assessment of antibiotic utilization employing the ATC/DDD and DU 90% methodologies has been performed at Taman Husada Bontang Regional General Hospital. The study objectives focus on characterizing antibiotic consumption patterns among CAP patients at Taman Husada Bontang Regional General Hospital during 2024, employing both ATC/DDD and DU90% analytical frameworks.

Methodology

The present study constitutes a retrospective, descriptive quantitative analysis utilizing data extracted from medical records at Taman Husada Bontang Regional General Hospital during the period of January to June 2024. The purposive sampling approach identified eligible participants based on: patients diagnosed with community-acquired pneumonia who were hospitalized and received antibiotic therapy during the period of January to June 2024; patients within the productive age range (19–39 years); and patients with complete and clearly legible medical records. Eighty-three patients met all specified inclusion criteria for analysis.

Observational data were derived from the medical documentation of hospitalized pneumonia patients during the specified timeframe. Researchers employed a structured data capture tool to systematically record: patient identifiers (initials), age, sex, length of stay, antibiotic prescriptions (including drug class, pharmaceutical form, delivery method, dose, and course length). Data were processed descriptively and quantitatively. Quantitative data analysis was performed using Microsoft Excel 2019, and the results are presented in tables and percentages.

Result and Discussion

1. Characteristics of Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital

According to the research findings presented in Table 1, the patient population consisted of 49 males (59%) and 34 females (41%). The predominance of male patients may be associated with a higher prevalence of both active and passive smoking among men, which contributes to increased exposure to cigarette smoke—a well-established risk factor for pneumonia.

Exposure to tobacco smoke has been shown to impair the body's natural immune defenses, thereby increasing susceptibility to respiratory infections such as pneumonia (Prasetya, 2023).

Table 1. Characteristics of Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital (Secondary Data, 2024)

Description	Number of Patients (n=83)	Percentage (%)
Age (years)		
19-39	83	100
40-59	0	0
≥ 60	0	0
Gender		
Male	49	59
Female	34	41
Length of Stay (days)		
≤3	6	7,2
4-6	42	50,6
7-14	31	37,3
≥15	4	4,8
Total Length of Stay (days)	619	

Analysis demonstrated that most pneumonia cases (50.6%) at the institution during the study year required 4-6 days of hospitalization. This duration of admission - calculated from diagnosis to discharge - serves dual purposes: it facilitates the computation of antibiotic consumption via the DDD calculations while simultaneously functioning as a key performance indicator for hospital care quality.

Patients with bacterial infections typically require hospitalization for approximately 7 to 10 days (Andarsari, 2022), with variations occurring according to clinical severity. Several factors influence the length of stay, including both non-modifiable factors (such as age and primary diagnosis) and modifiable factors (such as the risk of nosocomial infection). Notably, Indonesia's national pneumonia management standards (2023) specify a 3-5 day empirical antibiotic regimen for community-acquired cases in adults. (Health Ministry of Indonesia, 2023).

2. Patterns of Antibiotic Utilization Among Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital

The data analysis reveals Ceftriaxone as the most commonly administered antibiotic (representing 63.6% of prescriptions) for hospitalized pneumonia cases during the study period. This prescribing trend is consistent with the treatment protocols recommended in two authoritative Indonesian guidelines: the Respirology Society's 2021 clinical practice standards and the Ministry of Health's 2023 national pneumonia management directives (The Indonesian Society of Respirology, 2021; Health Ministry of Indonesia, 2023).

The 2023 National Guidelines specify two recommended therapeutic approaches for hospitalized patients with mild-to-moderate community-

acquired pneumonia: combination therapy utilizing a beta-lactam antimicrobial (with specified dosing regimens for Ampicillin-Sulbactam, Cefotaxime, Ceftriaxone, or Ceftaroline) paired with a macrolide (Azithromycin or Clarithromycin), or alternatively, monotherapy employing respiratory fluoroquinolones (Levofloxacin or Moxifloxacin at standard doses). These protocols are corroborated by the 2021 Indonesian Pulmonary Physicians Association Guidelines, which endorse comparable regimens for non-critically ill hospitalized patients

Table 2. Patterns of Antibiotic Utilization Among Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital
(Secondary Data, 2024)

Antibiotic	ATC Code	Dosage Form	Route	Amount (gram)	Percentage (%)
Ceftriaxone	J01DD04	Vial	Intravenous	526	63,6
Cefotaxime	J01DD01	Vial	Intravenous	39	4,7
Ceftazidime	J01DD02	Vial	Intravenous	132	15,9
Cefoperazone Sulbactam	J01DD62	Vial	Intravenous	9	1,1
Ciprofloxacin	J01MA02	Bottle	Intravenous	1,6	0,2
Levofloxacin	J01MA12	Bottle	Intravenous	58,5	7,1
Meropenem	J01DH02	Vial	Intravenous	45	5,4
Azitromysin	J01FA10	Tablet	Oral	16,5	2,0
Total				827,6	100

3. Quantity of Antibiotic Utilization of Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital

Data analysis indicated total antibiotic usage reached 80.3 DDD per 100 patient-days among pneumonia patients. Ceftriaxone injection emerged as the predominant agent (42.5 DDD/100 patient-days) among the eight prescribed antibiotics. Based on WHO standards (2 gram daily dose), this consumption level corresponds to approximately 42-43 treatment courses per 100 patient-days.

The elevated DDD/100 patient-days value for ceftriaxone suggests potential irrational use, particularly with regard to the duration and quantity of administration. According to standard guidelines, Ceftriaxone should be administered at a dosage of 2 g/day for a duration of 7 days. However, the data indicated that many patients received Ceftriaxone therapy beyond the recommended duration, contributing to the increased DDD value.

Ceftriaxone exhibits broad-spectrum antibacterial activity, including efficacy against anaerobic pathogens such as *Haemophilus influenzae* and atypical organisms including *Mycoplasma and Chlamydia*. These characteristics make it a commonly preferred option for empirical treatment of pneumonia (Rahmah, 2022).

Levofloxacin demonstrated the second highest utilization among prescribed antibiotics, reaching 18.9 defined daily doses per 100 patient-days of treatment. Based on the WHO-defined DDD of 0.5 grams per day, this suggests that

approximately 19–20 patients per 100 days of care received parenteral levofloxacin therapy at RSUD Taman Husada Bontang. Levofloxacin is recommended as a first-line empirical antibiotic for hospitalized patients with both mild-to-moderate and severe pneumonia, according to the guidelines issued by The Indonesian Society of Respirology (The Indonesian Society of Respirology, 2021).

This advanced-generation fluoroquinolone displays broad-spectrum activity against diverse bacterial groups relevant to pulmonary infections. Clinically significant targets include gram-negative (e.g., *H. influenzae*), gram-positive (notably *S. pneumoniae*), and atypical respiratory pathogens (*Legionella spp., M. pneumoniae, C. pneumoniae*). According to Widyati et al. (2021), its bactericidal mechanism exhibits concentration-dependent kinetics, with enhanced efficacy at higher pharmacological concentrations.

With a total usage of 8.9 DDD/100 patient-days, azithromycin emerged as the third most utilized antimicrobial agent. When calculated against the WHO-defined DDD of 0.3 gram daily, this equates to roughly 9-10 treatment courses per 100 patient-days. The antibiotic is widely employed for atypical pneumonia cases attributable to *Mycoplasma, Chlamydia*, and *Legionella* organisms, where it acts by blocking bacterial protein production to inhibit microbial growth.

The study identified considerable antibiotic use (80.3 DDD/100 patient-days) in the management of severe pneumonia at the institution, indicating potential concerns regarding prescription rationality. These findings thus offer valuable evidence to support the optimization of antimicrobial use protocols in clinical settings. Importantly, the DDD metric functions as a reliable quantitative measure, where increased values directly signify higher antibiotic utilization intensity (Khairani et al., 2023).

The total DDD/100 patient-days at Taman Husada Bontang Regional General Hospital was lower than that reported in a 2021 study conducted at the NTB Provincial Hospital, which recorded antibiotic usage among hospitalized community-acquired pneumonia patients at 82.62 DDD/100 patient-days using the ATC/DDD methodology. In that study, Levofloxacin had the highest utilization, with a DDD value of 56.00 per 100 patient-days (Farhaini, 2023).

The antibiotic usage rate at Taman Husada Bontang Hospital exceeded that reported in a comparable study conducted at Airlangga University Hospital's ICU, which recorded a total consumption of 73.64 DDD/100 patient-days for pneumonia treatment. In the Surabaya study, Levofloxacin (21.92 DDD) and Ceftriaxone (20.45 DDD) per 100 patient-days emerged as the predominant agents (Andarsari, 2022).

Table 3. Quantity of Antibiotic Utilization of Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital (Secondary Data, 2024)

Antibiotic Classes	ATC Code	DDD Standar WHO (gram)	Number of Antibiotics Used (gram)	Total Length of Stay (days)	DDD/100 Patient-Days
Ceftriaxone	J01DD04	2	526	619	42,5
Cefotaxime	J01DD01	4	39		1,6
Ceftazidime	J01FA10	4	132		5,3
Cefoperazone Sulbactam	J01DD62	9	9		0,4
Ciprofloxacin	J01MA02	0,8	1,6		0,3
Levofloxacin	J01MA12	0,5	58,5		18,9
Meropenem	J01DH02	3	45		2,4
Azitromycin	J01FA10	0,3	16,5		8,9
Total			827,6		80,3

4. Drug Utilization Profile of 90% Antibiotics for Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital

The 90% Drug Utilization (DU) profile of antibiotic use among hospitalized pneumonia patients at RSUD Taman Husada Bontang in 2024 is presented in Table 4. Ceftriaxone (52.9%) and Levofloxacin (23.5%) accounted for the highest proportions of antibiotic use in community-acquired pneumonia. This trend is attributable to the frequent use of these antibiotics, both as monotherapy and in combination regimens, in the management of pneumonia at the institution.

Given their high usage rates, both Ceftriaxone and Levofloxacin fall within the 90% DU segment and should be closely monitored due to their potential contribution to antimicrobial resistance. One recommended strategy to mitigate resistance is the implementation of antibiotic restriction policies, which may include rotating or replacing specific antibiotics during defined time intervals to minimize selective pressure on bacterial populations (Trisia et al., 2020).

The application of the 90% Drug Utilization (DU) method serves as a useful tool for monitoring and optimizing antibiotic prescribing patterns. This approach enables more rational use of antibiotics by highlighting the most frequently used agents and identifying potential areas for intervention. Selection of antibiotics should be guided by clinical efficacy, microbial sensitivity, the patient's clinical condition, antimicrobial spectrum, availability in the hospital formulary, and diagnostic appropriateness, while minimizing the risk of reinfection (Health Ministry of Indonesia, 2011).

According to a study performed at NTB Provincial Hospital in 2021, the DU90% analysis for hospitalized community-acquired pneumonia cases was dominated by three antibiotics: Levofloxacin (accounting for 67.78% of

prescriptions), followed by Ceftriaxone (15.68%) and Moxifloxacin (7.55%) (Farhaini, 2023).

Table 4. Drug Utilization Profile of 90% Antibiotics for Community-Acquired Pneumonia Patients at Taman Husada Bontang Regional General Hospital (Secondary Data, 2024)

No	Golongan dan Nama Antibiotik	Kode ATC	DDD/100 Patient-days	% Drug Use	DU 90%
1	Ceftriaxone	J01DD04	42,5	52,9	90,0
2	Levofloxacin	J01MA12	18,9	23,5	
3	Azithromycin	J01FA10	8,9	11,1	
4	Ceftazidime	J01FA10	5,3	6,6	
5	Meropenem	J01DH02	2,4	3,0	10,0
6	Cefotaxime	J01DD01	1,6	2,0	
7	Cefoperazone Sulbactam	J01DD62	0,4	0,5	
8	Ciprofloxacin	J01MA02	0,3	0,4	
	TOTAL		**80,3**	**100,0**	**100,0**

Conclusion

The quantity of antibiotic consumption community-acquired pneumonia (CAP) patient at Taman Husada Bontang Regional Hospital during the period of January-June 2024 showed that the highest quantity based on DDD/100 patient-days was Ceftriaxone, with a value of 42.5 DDD/100 patient-days. The next most commonly used antibiotics were Levofloxacin (18.8 DDD/100 patient-days) and Azithromycin (8.9 DDD/100 patient-days). The antibiotics included in the Drug Utilization 90% segment were Ceftriaxone (52.9%), Levofloxacin (23.5%), Azithromycin (11.1%), and Ceftazidime (5.3%)

Declaration of Competing Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

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