The Rationality and Quantity of Antibiotic Use in the Intensive Care Unit of Pandega Pangandaran Regional Hospital

Sherly Gautama Putri[1], Nur Rahayuningsih[1*], Keni Idacahyati[2]
[1]*Faculty of Pharmacy, Bakti Tunas Husada University, Tasikmalaya*
[2]*Pandega Pangandaran Regional Hospital*
nurrahayuningsih@universitas-bth.ac.id

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Abstract: Respiratory disorders often require intensive care management and empirical antibiotic therapy, which may lead to inappropriate use. This study aimed to evaluate the rationality of antibiotic use in the Intensive Care Unit of Pandega Pangandaran Regional Hospital in 2023 based on the Gyssens criteria and to measure the quantity of antibiotic consumption using the ATC/DDD method recommended by the World Health Organization. This study is a descriptive study using retrospective data from patient medical records. The Gyssens criteria were employed for qualitative evaluation, while the ATC/DDD method assessed quantitative consumption. Consecutive sampling was used to select Intensive Care Unit patients who received antibiotic therapy. The analysis revealed that 33.8% of antibiotic prescriptions were rational (category 0), while irrational use was identified in category IIIB (duration too short, 23.8%), category IVA (more effective alternatives available, 32.5%), and category IVC (less expensive alternatives available, 10.0%). Quantitative analysis showed that levofloxacin had the highest consumption rate (56.48 DDD/100 patient-days), followed by ceftriaxone (46.40 DDD/100 patient-days). These findings indicate that antibiotic prescribing practices in the Intensive Care Unit were not fully rational, primarily due to the absence of culture and sensitivity testing. Strengthening antimicrobial stewardship and incorporating microbiological results into prescribing decisions are essential to optimize antibiotic use and reduce resistance risks.

1 INTRODUCTION

Disorders of the respiratory system occur when the respiratory tract's capacity to absorb oxygen is compromised. Causal agents such as bacteria, viruses, microorganisms, and other chemicals interact with hemoglobin to bring about these disorders (Gulo et al., 2023).

Based on previous research conducted at the Sanglah General Hospital's intensive care unit in Denpasar, it was found that respiratory illnesses were prevalent as primary diagnoses, with a mortality rate of 22.2%. Furthermore, respiratory conditions were identified as one of the leading causes of diseases at the Pandega Pangandaran Regional Hospital in 2023 (Brahmani & Hartawan, 2019).

The utilization of antibiotics is crucial for the treatment of bacterial infections. Among various medical settings, the Intensive Care Unit stands out as a significant consumer of antibiotics (Hidayat et al., 2021).

The extensive utilization of antibiotics raises various concerns and challenges for global health, notably concerning bacterial resistance. This resistance considerably impacts societal and economic dimensions, while also elevating the risk of mortality and morbidity (Kemenkes RI, 2011).

Antibiotic resistance presents a significant challenge that can be effectively tackled by evaluating antibiotic use through two distinct methods. The qualitative approach involves the use of the Gyssens method, while the quantitative approach utilizes ATC/DDD (Anatomical Therapeutic Chemical/Defined Daily Dose) measurements.

The approach aims to quantitatively evaluate the overall antibiotic consumption. In contrast, the Gyssens technique provides a comprehensive analysis by categorizing antibiotics into six groups based on various criteria such as cost, duration of use, dosage, spectrum coverage, appropriate indication, effectiveness, toxicity, and administration interval (S. A. Putri & Oktavilantika, n.d.)..

The primary aim of this study is to determine, using the Gyssens and ATC/DDD criteria, the projected utilization of antibiotics in the intensive care unit at Pandega Pangandaran Regional Hospital for the year 2023.

2 METHODS

This descriptive study utilized the Gyssens and ATC/DDD methods to evaluate the rationality of antibiotic use qualitative and quantitative. Data were collected retrospective from the medical records of

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patients with respiratory disorders in the Intensive Care Unit of Pandega Pangandaran Regional Hospital who received antibiotic therapy and having complete medical records.

3 RESULTS

Patient Characteristics

There were 80 patients with respiratory disorders who met the inclusion criteria in the Intensive Care Unit of Pandega Pangandaran Regional Hospital.

Table 1 : Characteristics of Intensive Care Unit Patients at Pandega Pangandaran Regional Hospital

Characteristics	Patients	Percentage (%)
Gender		
Male	46	57.5
Female	34	42.5
Total	**80**	**100**
Age		
Neonatal and Infants (0-1 years)	8	10.0
Toddlers (1-5 years)	1	1.3
Preschool Children (5-6 years)	-	-
Children (6-10 years)	2	2.5
Teenagers (10-19 years)	1	1.3
Adults (19-44 years)	13	1.3
Pre-Elder (45-59 years)	18	22.5
Elderly (>60 years)	37	46.3
Total	**80**	**100**
Diagnosis		
Respiratory Failure	46	57.5
Acute Respiratory Distress Syndrome	8	10.0
Pneumonia	19	23.8
Bronchopneumonia	7	8.8
Total	**80**	**100**
Length of Treatment		
1-3 days	42	52.5
4-6 days	20	25.0
>7 days	18	22.5
Total	**80**	**100**
Discharged status		
Improved	11	13.8
Referred	6	7.5
Died	59	73.8
Forced referred	4	5.0
Total	**80**	**100**

Qualitative Assessment of Antibiotics

The results of Gyssens analysis showed that 33.8% of antibiotic prescriptions were rational (category 0), while irrational use was identified in category IIIB (too short duration, 23.8%), category IVA (more effective alternatives available, 32.5%), and category IVC (cheaper alternatives available, 10.0%).

Table 2 : Qualitative Assessment of Antibiotics

Gyssens Category	Number	Percentage (%)
0 (Appropriate/rational)	27	33.8
I (Not on time)	-	-
IIA (Incorrect dosage)	-	-
IIB (Incorrect administration interval)	-	-
IIC (Inappropriate route of administration)	-	-
IIIA (Prolonged use)	-	-
IIIB (Brief use)	19	23.8
IVA (There are more effective antibiotics)	26	32.5
IVB (There are antibiotics which are less toxic/safe)	-	-
IVC (There are cheaper antibiotics)	8	10.0
IVD (There are antibiotics with a narrower spectrum)	-	-
V (No indication)	-	-
VI (Medical record data is incomplete)	-	-
Total	80	100

Quantitative Assessment of Antibiotics.

Quantitative analysis showed that levofloxacin had the highest consumption rate (56.48 DDD/100 patient-days), followed by ceftriaxone (46.40 DDD/100 patient-days).

ATC Code	Antibiotics	Total DDD	DDD WHO	DDD/100 Patient Days
J01MA12	Levofloxacin	192.50	0.5	55.16
J01DD04	Ceftriaxone	161.93	2	46.40
J01DH02	Meropenem	34.95	3	10.02
J01DD02	Ceftazidime	110.88	4	31.77
J01FA10	Azithromycin	46.19	0.5	13.24
J01DD01	Cefotaxime	1.40	4	0.40
J01MA14	Moxifloxacin	10.00	0.4	2.87
J01GB06	Amikacin	0.36	1	0.10
J01XD01	Metronidazole	0.12	1.5	0.03
J01CR01	Ampicillin Sulbactam	4.67	6	1.34
J01GA01	Streptomycin	4.00	1	1.15
J04AK02	Ethambutol	3.33	1.2	0.96

Table 3 : Quantitative Assessment of Antibiotics

4 DISCUSSION

Patient Characteristics

Based on the patient characteristics in Table 1, it shows that the majority of patients in this study were male (57.5%). This is in line with the population distribution in Indonesia in 2023, where women constitute 49.92% of the population and men 50.08%. The projected population of Pangandaran Regency in 2023 is 440,177 people, consisting of 220,575 men and 219,602 women. The male immune system can deteriorate due to disease, degenerative disorders, and unhealthy lifestyles. Additionally, men's susceptibility to lung infections is attributed to their smoking habits and the decreased efficiency of lung macrophages in phagocytosis, which is essential for defending the

lungs against foreign particles. Consequently, men are at a higher risk of developing lung diseases (Hedi et al., n.d.).

Research indicates that patients categorized as senior citizens, aged over 60, constitute the largest portion of the patient demographic, accounting for 46.3% of the total population. Prior studies have demonstrated that diminished organ function as a result of illness or natural aging processes prompts older individuals to seek medical care more regularly. Advancing age leads to a reduction in physiological reserves essential for maintaining bodily equilibrium in the face of illness. Consequently, the body's ability to sustain homeostasis declines with age, heightening the risk of mortality (Khasanah et al., 2023).

The research findings show that respiratory failure was the predominant diagnosis, affecting 46 individuals, representing 57.5% of the patients in the intensive care unit. Respiratory failure occurs when the lungs are unable to maintain the body's oxygen and carbon dioxide levels within a sTable range (Hayati et al., 2019).

Respiratory complications often arise from lung conditions such as pneumonia, sepsis, heart failure, and neurological disorders. Additionally, respiratory failure can result from a blockage in the respiratory tract, characterized by excessive secretions impeding proper coughing (Sukriya et al., 2022).

Oxygen therapy is considered the primary intervention for managing respiratory failure in individuals. In cases of respiratory infections, broad-spectrum antibiotics such as quinolones and macrolides are commonly utilized. Respiratory failure is a significant contributor to mortality and often necessitates intensive care unit admission (Irawati et al., 2021).

Pneumonia ranks as the second most prevalent diagnosis, accounting for 19.8% of cases. Pneumonia is the acute inflammation of the lung parenchyma caused by various pathogens such as bacteria, fungi, viruses, and parasites (Kemenkes RI, 2023).

Community-acquired pneumonia (CAP) is the most common type of pneumonia observed in the intensive care unit at Pandega Pangandaran Regional Hospital. This form of pneumonia is caused by pathogens acquired outside of the hospital setting or within the community. In cases of hospitalized patients diagnosed with CAP, the standard treatment comprises β-lactam antibiotics (such as cefotaxime, ceftriaxone, ampicillin sulbactam) administered intravenously, along with macrolides or respiratory fluoroquinolones (Perdaka et al., 2020).

For eight patients (10.0%), Acute Respiratory Distress Syndrome (ARDS) was the third diagnosis. In response to a variety of causal circumstances, lung tissue is injured in ARDS, a dangerous and potentially fatal lung illness. Reduced lung aeration, elevated blood vessel permeability, and inflammation are symptoms of this illness. Corticosteroids are a common pharmaceutical treatment for ARDS (Fatoni & Rakhmatullah, 2021). Broad spectrum antibiotics like quinolones and macrolides are used in antibiotic therapy to treat acute respiratory distress syndrome (ARDS) when respiratory infections arise (Fujishima, 2023).

The prevalence of bronchopneumonia was noted at 8.8%, making it the fourth most commonly diagnosed condition among 7 individuals. Bronchopneumonia, an infection impacting the bronchi or airways leading to the lungs, poses a significant health risk. This condition, which can be triggered by various pathogens such as fungi, viruses, or bacteria, is especially perilous for individuals with compromised immune systems, as well as for the elderly and young individuals. The recommended antibiotic regimen for bronchopneumonia typically includes broad-spectrum antibiotics, such as a combination of beta-lactam/clavulanate with aminoglycosides or third-generation cephalosporins (Dicky & Wulan, 2017).

The duration of the patient's stay is an important factor to consider in intensive care units. There are three main categories for the length of stay: 1 to 3 days, 4 to 6 days, and more than 7 days. According to our data, 52.5% of the total patients (42 out of 80) had an intensive care units stay of 1 to 3 days, making it the most common category. This trend aligns with earlier research, which indicated that a significant majority (68.57%) of Intensive care unit patients who passed away had an inpatient stay of 1 to 3 days. These findings underline the relevance of the length of intensive care unit stay in patient outcomes and warrant further investigation (Putra, 2021).

In consideration of the patient's status at discharge, the predominant proportion (59 patients, or 73.8% of the total) exhibited a deceased status. When a patient presents with respiratory failure and is subsequently admitted to the intensive care unit, they are categorized as critically unwell. The intensive care unit poses a significant likelihood of mortality given this circumstance. Additionally, there exists a correlation between the duration of hospital stay and the gravity of the patient's condition (Khasanah et al., 2023).

Qualitative Assessment of Antibiotics

This study used the Gyssens method to analyze the rationality of antibiotic use in the Pandega Pangandaran intensive care unit. Antibiotic use is classified as rational if it aligns with group 0, and irrational if it corresponds to categories I–IV. The Gyssens criteria for evaluating antibiotic usage encompass considerations such as cost, spectrum coverage, duration of use, efficacy and toxicity profiles of antibiotics, as well as the dosage, administration intervals, and indications for their use (Kemenkes RI, 2013).

The Gyssens-based evaluation requires a comprehensive collection of the patient's medical

record data falling within category VI. Adequate data is crucial for the assessment of antibiotic usage, as it is impossible to conduct a thorough evaluation without complete information. In our trial, the more successful antibiotic category, Iva, encompassed 26 patients, accounting for 32.5% of the total proportion. Our approach to antibiotic use is based on established research articles and guidelines. The Decree of the Minister of Health of the Republic of Indonesia No. HK.01.07/MENKES/2147/2023 outlines the national guidelines for medical services in the management of pneumonia among adults. These guidelines form the basis of our recommendations for pneumonia diagnosis. In addition, the journal titled "Guideline-based Management of Acute Respiratory Failure and Acute Respiratory Distress Syndrome" is a valuable reference for diagnosing respiratory failure and acute respiratory distress syndrome (Fujishima, 2023).

In the diagnosis of bronchopneumonia, the reference utilized is the "Management of Bronchopneumonia at Abdul Moeloek Hospital" journal, along with other relevant research journals that corroborate and contribute to the research. Should fall into the category IVa, the potential cause may be attributed to the administration of empirical antibiotics that lack documentation in established guidelines or pertinent research literature. Furthermore, it may also stem from the availability of antibiotics with superior efficacy in combating the specific type of infection afflicting the patient (Putra, 2021).

When doctors decide which antibiotics to prescribe, they do not limit themselves to the antibiotics recommended in clinical practice guidelines. They also use their knowledge and experience to guide their antibiotic choices, but still consider factors related to microbiology (bacterial resistance), pharmacology (side effects, efficacy, antibiotic class, drug cost), and clinical conditions (patient profile and condition). comorbidities, symptoms, development of infection, history of antibiotic treatment). All these factors should be considered when establishing interventions to improve antibiotic prescribing (Krishnakumar & Tsopra, 2019).

In a study conducted, it was found that eight individuals (10.0%) were categorized under the IVC group, which opted for more cost-effective antibiotics while still ensuring their efficacy. For example, the pneumonia management guidelines outlined by the Indonesian Ministry of Health recommend the use of levofloxacin for treating community-acquired pneumonia (CAP) within the IVC category. These guidelines specify that ceftriaxone, a β-lactam antibiotic, is the preferred standard treatment for CAP due to its lower cost compared to levofloxacin (Kemenkes RI, 2023).

In this study, nineteen individuals (23.8%) were classified into group IIIB due to the demise of the patient and the necessity to discontinue the prompt administration of antibiotics. Conversely, category 0 signifies the appropriate and judicious utilization of antibiotics. Generally, the logical prescription of antibiotics based on Gyssens' criteria leads to an improvement in the clinical symptoms of patients. Although the influence of Gyssens' criteria

is not entirely significant, patients still exhibit symptomatic improvement even when the administered antibiotic is not sensitive. Additionally, the utilization of antibiotics in category 0 represents rational usage, whereas the use of antibiotics in categories I–IV represents irrational usage. It is noteworthy that twenty-seven patients (33.8%) in this study were categorized into group 0, indicating the rational usage of antibiotics (Perhimpunan Dokter Paru Indonesia, 2021).

The research findings present evidence that the prevalent irrational use of antibiotics in the intensive care unit at Pandega Pangandaran Regional Hospital stems from the incorrect administration of antibiotics. One of the contributing factors to this issue is the absence of bacterial culture capabilities at the hospital, rendering the sensitivity culture results unusable as a reference. Consequently, decisions regarding antibiotic usage have been primarily reliant on empirical therapy and laboratory testing. This practice has led to a situation where the employment of antibiotics in the Intensive Care Unit at Pandega Pangandaran Regional Hospital does not entirely align with the criteria set forth by Gyssens.

Quantitative Assessment of Antibiotics

In the context of managing antibiotic resistance in hospitals, evaluating the quantity of antibiotic use is essential. Accurate parameters are necessary to quantify this usage. For this investigation, the metric DDD/100 patient days was employed. This measurement allows for benchmarking with standard data and comparison with other healthcare facilities. According to the assessment data from January to December 2023, levofloxacin emerged as the most frequently used empirical antibiotic, with an average of 55.16 DDD/100 patient days. Ceftriaxone followed with an average of 46.40 DDD/100 patient days (Raini, n.d.).

According to previous research conducted at a hospital in the Cirebon Regency, levofloxacin emerged as the most commonly prescribed antibiotic, with an average of 143.2 DDD/100 patient days. These observations align with similar studies carried out at the University of Sumatra Hospital, where ceftriaxone usage accounted for 34.5% and levofloxacin for up to 38.8% of antibiotic prescriptions (Megawati et al., n.d.).

The utilization of antibiotics can be influenced by a variety of factors, including institutional type, patient demographics, adherence to clinical guidelines, drug availability, and access to information. Antibiotics are

more frequently prescribed in settings where the DDD/100 patient-days value is elevated. Prolonged treatment duration and unnecessary prescriptions are associated with increased rates of antibiotic usage (Raini, n.d.).

Levofloxacin, belonging to the fluoroquinolone class, is considered the preferred treatment for both gram-positive and gram-negative bacterial infections due to its wide spectrum of activity. Additionally, it has demonstrated efficacy in the treatment of respiratory tract infections and exhibits a high rate of therapeutic success (Kemenkes RI, 2013).

The concentrations of respiratory fluoroquinolones, such as levofloxacin, exhibit higher levels in lung tissue as compared to plasma. Similar to beta-lactams and macrolides, respiratory fluoroquinolones demonstrate a robust safety profile. Levofloxacin achieves a bioavailability rate of 85–95% within the body (Rachmawati et al., 2023) (Perhimpunan Dokter Paru Indonesia, 2021).

Ceftriaxone, a β-lactam antibiotic, is highly effective against both gram-positive and gram-negative bacteria, rendering it the second most frequently utilized antibiotic following levofloxacin. Notably, it demonstrates resistance to the β-lactamase enzyme, thereby effectively combating a wide spectrum of illnesses, including community-acquired pneumonia. Additionally, ceftriaxone possesses an extended half-life compared to other third-generation cephalosporins, allowing for less frequent dosing, potentially reducing costs and enhancing treatment convenience (Raini, n.d.).

The significance of reducing antibiotic use to combat antibiotic resistance cannot be overstated. Lowering the defined daily dose (DDD) value of antibiotics can decrease the likelihood of resistance, aligning with the principles of sensible antibiotic use. This approach emphasizes the importance of minimizing antibiotic usage, which in turn facilitates improved therapy selection. Conversely, increased antibiotic use heightens the global health risk due to the potential for bacterial resistance (Nasution et al., 2023).

In this research where the specific pathogen is unidentified, broad-spectrum antibiotics are often administered to cover a wide range of potential infectious gram-positive and gram-negative bacteria. While this approach is pragmatic, the use of multiple types of antibiotics concurrently amplifies the risk of antibiotic resistance. To address this concern, it is imperative for healthcare institutions, such as the Pandega Pangandaran Regional Hospital, to establish a microbiological laboratory. Through such a facility, the responsible use of antibiotics can be ensured, thereby mitigating the risk of antibiotic resistance (Perhimpunan Dokter Paru Indonesia, 2021).

5 CONCLUSIONS

In the intensive care unit of Pandega Pangandaran Regional Hospital in 2023, a research study was conducted using the Gyssens method to evaluate antibiotic usage. The findings revealed that 33.8% of the cases demonstrated rational antibiotic use (category 0), while 66.3% fell into the category of irrational use, with 23.8% classified as category IIIB, 32.5% as category IVA, and 10.0% as category IVC. These results suggest a lack of utilization of culture sensitivity data for antibiotic prescribing. Furthermore, employing the ATC/DDD method, it was found that levofloxacin and ceftriaxone were the most commonly used antibiotics in the Intensive Care Unit , with usage rates of 55.16 DDD/100 patient days and 46.40 DDD/100 patient days, respectively.

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