

# Ceftriaxone Utilization in Adult Pneumonia Inpatients: A Retrospective Medical Record Review

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## ABSTRACT

Adult pneumonia remains a major cause of hospitalisation and is frequently managed empirically with broad-spectrum antibiotics. This study aimed to evaluate ceftriaxone utilisation among adult pneumonia inpatients at Toto Kabila Hospital using a retrospective review of medical records. Data were collected for the period January–December 2024 and assessed descriptively, focusing on patient characteristics and key components of rational antibiotic use, including indication, drug selection, dose, dosing interval, and duration, with reference to the Indonesian national clinical guideline (PNPK Pneumonia in Adults, 2023) and international community-acquired pneumonia recommendations. A total of 43 adult inpatients met the eligibility criteria; males accounted for 26 cases (60.5%). Ceftriaxone was the predominant empirical antibiotic, most commonly prescribed as a twice-daily regimen. When evaluated against guideline-based parameters, the overall pattern suggested stronger alignment in antibiotic selection and total daily dose than in dosing interval and treatment duration documentation, indicating opportunities for standardisation. These findings support targeted antimicrobial stewardship interventions, particularly the harmonisation of prescribing practices with guideline-concordant dosing schedules and clearer documentation of clinical severity and therapeutic endpoints to optimise effectiveness while reducing unnecessary antibiotic exposure.



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## Keywords:

Adult pneumonia; Ceftriaxone; Drug use evaluation; Guideline concordance; Antimicrobial stewardship; Retrospective study

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## 1. Introduction

Adult pneumonia remains a clinically significant infectious disease because it contributes to substantial morbidity, frequent hospitalisation, and complex therapeutic decision-making, particularly when patients present with heterogeneous symptoms and varying clinical severity. In this context, rational drug use is essential to ensure that pharmacotherapy is provided based on clear indications, appropriate drug selection, correct dosing, and suitable administration schedules to maximise effectiveness while minimising preventable harm and unnecessary antimicrobial exposure [1]. Practical discussions in Indonesian scientific forums have also highlighted that variability in

prescribing behaviour can occur due to diagnostic uncertainty, workload, and differences in local clinical routines, which further strengthens the rationale for evaluating real-world prescribing patterns in hospital settings [2].

In inpatient care, third-generation cephalosporins – especially ceftriaxone – are frequently used empirically for pneumonia because of their broad antibacterial spectrum and operational convenience. However, evidence from Indonesian hospital-based studies indicates that the use of third-generation cephalosporins in pneumonia patients can show heterogeneity in prescribing patterns, including variability in regimen selection and administration practices, thereby creating a meaningful space for drug use evaluation to identify gaps in appropriateness and opportunities for standardisation [3]. From a microbiological perspective, pneumonia is also commonly associated with bacterial pathogens such as *Klebsiella pneumoniae*, and awareness of pathogen relevance reinforces why empirical antibiotic decisions should remain anchored to rational-use principles and local clinical considerations [4]. Additionally, environmental and host-related risk factors may influence respiratory vulnerability, including reduced lung function in communities exposed to air pollutants, which can complicate pneumonia burden and downstream hospital utilisation [5].

International clinical guidance for community-acquired pneumonia – particularly in elderly patients – emphasises structured assessment, severity consideration, and therapy that is aligned with guideline-based regimens to improve outcomes and reduce inappropriate antimicrobial exposure [6]. Within Indonesia, retrospective evaluations of antibiotic use among pneumonia patients have similarly demonstrated the importance of systematically reviewing indication, drug choice, dose, and dosing frequency as core parameters of appropriate therapy [7]. Beyond infection-specific considerations, comorbid conditions may modulate pneumonia susceptibility and prognosis; for instance, epidemiological evidence suggests that elevated blood pressure can be associated with increased pneumonia risk, highlighting how chronic disease profiles may intersect with infection burden in adult populations [8].

Moreover, chronic respiratory morbidity such as COPD-related breathlessness represents an additional clinical burden frequently encountered in routine care, potentially affecting presentation, therapeutic complexity, and hospital resource utilisation in respiratory patients [9]. Therefore, evaluating ceftriaxone utilisation in adult pneumonia inpatients at Toto Kabila Hospital, Indonesia, is scientifically justified to characterise prescribing patterns, assess concordance with rational-use principles and guideline expectations, and inform targeted antimicrobial stewardship improvement.

## **2. Methods**

### **Study Design and Setting**

This study was a descriptive observational study with a retrospective approach using secondary data from medical records. The study was conducted at Toto Kabila General Hospital, Bone Bolango Regency, Gorontalo Province, Indonesia. The methodological rationale followed the principles of rational drug use and drug use evaluation in clinical settings, focusing on the appropriateness of antibiotic therapy components (drug selection, dose, and administration instructions) [1], [3], [7], [14].

### **Study Period**

Medical record retrieval and data extraction were performed for the period July 2023 to July 2024.

### **Population, Sample, and Sampling Technique**

The study population comprised all adult inpatients diagnosed with pneumonia and treated at Toto Kabila General Hospital during the study period. The study sample consisted of 43 eligible cases. A purposive sampling technique was applied to select medical records that met the inclusion criteria and provided sufficient prescription information for evaluation, consistent with retrospective antibiotic use evaluation approaches reported in Indonesian hospital studies [3],[7].

### **Eligibility Criteria**

Inclusion criteria were adult patients ( $\geq 18$  years) hospitalised with a documented diagnosis of pneumonia and receiving a third-generation cephalosporin antibiotic during treatment. Medical records were required to contain core prescribing information, including antibiotic name, dose, dosing frequency/interval, and relevant demographic data (age and sex). Exclusion criteria included records with incomplete core prescription data that prevented evaluation of appropriateness parameters.

### **Variables and Operational Definitions**

The main variables included patient characteristics (age and sex), antibiotic therapy profile (antibiotic name, dose, dosing interval/frequency, route, and treatment duration if documented), and appropriateness indicators. Appropriateness was operationalised as: (1) correct medication (appropriate drug selection), (2) correct dosage (appropriate dose/total daily dose), and (3) correct usage instructions (appropriate administration directions, particularly dosing interval/frequency, route, and documentation of duration when available). The appropriateness assessment was primarily benchmarked against the Indonesian National Guidelines for the Medical Management of Pneumonia in Adults (PNPK, 2023) [11]. Where necessary for contextual comparison, international guidance for community-acquired pneumonia management in older adults was considered as a supporting reference [6].

### **Data Collection Procedure**

Secondary data were obtained from the Medical Records Department. Data extraction was conducted using a structured extraction sheet capturing demographics, diagnosis, antibiotic regimen details (name, dose, frequency/interval, and route), and duration of therapy when recorded. This approach aligns with prior retrospective evaluations of antibiotic use in pneumonia patients in Indonesian hospital settings [3], [7].

### **Appropriateness Assessment Criteria**

Each cephalosporin regimen was evaluated against PNPk (2023) criteria for adult pneumonia therapy [11]. "Correct medication" was determined by concordance between the prescribed antibiotic class/agent and guideline-recommended empirical therapy. "Correct dosage" was determined by whether the prescribed dose and/or total daily dose fell within the guideline dose range. "Correct usage instructions" were assessed based on the appropriateness of dosing frequency/interval and route as documented, and the completeness/clarity of treatment duration documentation when available, reflecting key parameters commonly applied in antibiotic use evaluation studies [1],[3],[7].

### **Data Analysis**

Data were analysed descriptively and presented as frequencies and percentages. Appropriateness indicators (correct medication, correct dosage, and correct usage instructions) were summarised to describe the pattern of guideline concordance in antibiotic prescribing [1],[11].

### Ethical Approval and Confidentiality

This retrospective study used secondary inpatient medical record data with no direct patient contact. Institutional permission for data collection was obtained from Toto Kabila Regional General Hospital (RSUD Toto Kabila) based on the Research Completion Certificate No. 890/RSUD-TK/009/II/2025 dated 12 February 2025. Patient confidentiality was ensured by anonymising data and reporting results in aggregate form only.

### 3. Results and Discussion

#### Patient Demographic Characteristics

A total of 43 adult inpatients diagnosed with pneumonia and treated at Toto Kabila General Hospital during the study period were included in the analysis. The demographic distribution is presented in **Table 1**. Male patients constituted 26 cases (60.5%), while female patients accounted for 17 cases (39.5%), indicating a male predominance among hospitalised adult pneumonia patients in this setting. Although this study is descriptive and does not test causality, the observed pattern can be discussed within the broader context of differential exposure to respiratory risk determinants and baseline pulmonary vulnerability, including environmental exposures and occupational or work-related respiratory conditions that may increase susceptibility to lower respiratory tract infections in adults [5], [13].

In terms of age structure, patients aged >50 years represented the largest proportion (23/43; 53.5%), followed by those aged 36–50 years (11/43; 25.6%) and 20–35 years (9/43; 20.9%). This distribution is clinically coherent because older adults are consistently described as a higher-risk group for pneumonia with potentially more complicated clinical trajectories, and guideline discussions for pneumonia management in elderly patients emphasise structured assessment and careful therapeutic considerations in this population [6]. Moreover, demographic predominance in older age groups is frequently accompanied by chronic comorbidity profiles that may influence pneumonia susceptibility and hospitalisation, including cardiometabolic risk factors and chronic respiratory burden [8], [9].

Table 1. Baseline demographic characteristics of adult pneumonia inpatients

Variable	Category	n	%
Sex	Male	26	60.5
	Female	17	39.5
Age group (years)	20–35	9	20.9
	36–50	11	25.6
	>50	23	53.5

#### Clinical Characteristics

##### Length of Hospitalisation

The distribution of length of hospital stay is presented in **Table 2**. Most patients were hospitalised for 3–6 days (26/43; 60.5%), followed by 7–10 days (16/43; 37.2%), while only one patient stayed for <3 days (1/43; 2.3%). From a clinical management perspective, this pattern is compatible with the expectation that a substantial proportion of adult pneumonia inpatients achieve clinical stabilisation within the first week, whereas a sizeable subgroup requires extended monitoring and therapy, which may reflect heterogeneity in severity at admission and the presence of concurrent comorbid conditions that complicate recovery and prolong inpatient observation [6],[11].

**Table 2.** Length of hospitalisation among adult pneumonia inpatients

Length of stay (days)	n	%
<3	1	2.3
3-6	26	60.5
7-10	16	37.2

Note: Percentages are calculated using total sample size ( $n = 43$ ) and rounded to one decimal.

### Comorbidity Profile

The comorbidity profile is summarised in **Table 3**. Hypertension was the most frequently recorded comorbidity (6 events; 16.6%), followed by type 2 diabetes mellitus and fever (each 5 events; 13.8%), and dyspepsia (4 events; 11.1%). These findings are clinically plausible because cardiometabolic conditions and chronic systemic vulnerability are widely recognised as relevant modifiers of pneumonia susceptibility and inpatient complexity, with epidemiological evidence indicating that elevated blood pressure may be associated with higher pneumonia risk [8]. In parallel, chronic respiratory burden—often reflected clinically by persistent breathlessness in COPD—can coincide with respiratory infections and may increase the need for inpatient care and monitoring [9]. Therefore, the observed comorbidity pattern supports the interpretation that adult pneumonia admissions in this setting commonly occur within a broader landscape of chronic disease profiles that can influence clinical course and resource utilisation [6].

**Table 3.** Recorded comorbidities among adult pneumonia inpatients

Comorbidity	n (events)	%
Hypertension	6	16.6
Type 2 diabetes mellitus	5	13.8
Fever	5	13.8
Dyspepsia	4	11.1
Other comorbidities	16	44.4
<b>Total</b>	<b>36</b>	<b>100.0</b>

Note: Patients may have more than one comorbidity. Percentages are calculated based on the total number of comorbidity events ( $n = 36$ ), not the number of patients.

### Antibiotic Utilisation and Appropriateness Assessment

#### Antibiotic Utilisation Pattern

All eligible adult pneumonia inpatients in this study received a third-generation cephalosporin, and the only agent recorded was ceftriaxone. The dominant regimen documented in the medical records was ceftriaxone 1 g intravenously twice daily (total 2 g/day), and the utilisation pattern together with the appropriateness indicators is summarised in **Table 4**. This highly standardised empirical approach can be advantageous when it is explicitly anchored to guideline criteria, adequately documented, and periodically evaluated through a drug use evaluation (DUE) framework to minimise unjustified variability and reduce avoidable antimicrobial exposure [1]. Similar retrospective evaluations in Indonesian hospital settings have applied comparable descriptive approaches to map antibiotic use patterns and identify stewardship targets [3], [7], [14].

**Table 4.** Ceftriaxone utilisation and appropriateness indicators in adult pneumonia inpatients

<b>Item</b>	<b>Result</b>	<b>n</b>	<b>%</b>
3rd-gen cephalosporin used	Ceftriaxone	43	100.0
Predominant regimen	1 g IV q12h (2 g/day)	43	100.0
Correct medication	Guideline-based selection (PNPK 2023)	43	100.0
Correct dosage	Total daily dose within PNPk range	43	100.0
Correct instructions*	Frequency/route documented (duration if available)	43	100.0

*Note: Specify the interval/duration standard applied if “correct instructions” is interpreted as strict guideline concordance*

**Appropriateness Assessment (Guideline Concordance)**

Appropriateness was evaluated using predefined indicators – correct medication (drug selection), correct dosage (total daily dose), and correct usage instructions (administration directions, particularly dosing frequency/interval, route, and documentation of duration where available) with the National Guidelines for the Medical Management of Pneumonia in Adults (PNPK, 2023) as the primary benchmark [11]. Overall, ceftriaxone selection as empirical therapy may be considered consistent with guideline based empirical coverage for hospitalised adult pneumonia in appropriate clinical contexts, and international guidance similarly emphasises structured assessment and appropriate empirical coverage, particularly in older adults and patients with higher clinical risk [6],[11].

Nevertheless, because retrospective medical records may variably document clinical severity, renal function, and therapeutic endpoints, the manuscript will be methodologically stronger if “appropriateness” is interpreted with explicit boundaries, particularly separating total daily dose concordance from dosing interval concordance, and clearly stating whether “correct usage instructions” was judged strictly against PNPk frequency recommendations or against institutional practice as recorded. Such transparency is central to DUE reporting and antimicrobial stewardship interpretation, preventing overstatement beyond what medical record data can validly support [1],[3],[7],[14].

Although this study provides an initial profile of ceftriaxone utilisation among adult pneumonia inpatients at Toto Kabila General Hospital, its findings should be interpreted cautiously due to several inherent limitations. The retrospective, medical record-based design depends on documentation completeness; key clinical determinants for appropriateness assessment (e.g., pneumonia severity, radiological and microbiological confirmation, oxygenation status, renal/hepatic function, and explicit therapeutic endpoints) may be missing or inconsistently recorded, which can constrain robust judgement of guideline concordance beyond what is written in the records [1],[11]. In addition, the single-centre sample (n = 43) and purposive selection limit generalisability and may introduce selection bias if incomplete records are systematically excluded [3],[7],[14]. The analysis also did not incorporate antibiotic consumption metrics (e.g., ATC/DDD), local antibiogram integration, or clinical outcomes (e.g., time to stability, treatment failure, readmission, mortality), and it did not comprehensively capture co-antibiotics, de-escalation, or duration of therapy decisions elements that are central to antimicrobial stewardship interpretation.

#### 4. Conclusion

This retrospective drug use evaluation describes a highly standardised empirical pattern of third-generation cephalosporin therapy among adult pneumonia inpatients at Toto Kabila General Hospital, Indonesia, in which ceftriaxone was the only agent recorded and was predominantly prescribed as 1 g intravenously every 12 hours (total 2 g/day). In the descriptive assessment against PNPk (2023), ceftriaxone selection and the total daily dose were classified as appropriate across all included records. Nevertheless, because the evaluation relied on secondary medical record documentation with limited severity stratification and variable completeness for administration details, the interpretation of “appropriate use” should be understood within the boundaries of what was documented, particularly for dosing interval and treatment duration. These findings support the need for strengthening antimicrobial stewardship through clearer documentation of clinical severity and therapeutic endpoints, harmonisation of prescribing practices with explicit guideline-based dosing schedules, and routine audit-and-feedback to ensure that standardised antibiotic use remains traceably concordant with national recommendations.

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#### Conflicts of Interest:

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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