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Identification of Drug-Related Problems (DRPs) in Patients with Pneumonia at the Regional Occupational Health Hospital

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Abstract: Pneumonia is a leading cause of mortality among children and remains a significant health issue in Indonesia. Inappropriate antibiotic use in pediatric patients can potentially lead to Drug-Related Problems (DRPs), which may impact treatment success. This study aimed to identify and categorize DRPs in pediatric patients with pneumonia at the West Java Provincial Occupational Health Regional General Hospital (RSUD Kesehatan Kerja) using the PCNE V9.1 classification system. A descriptive observational method with a retrospective approach was employed, analyzing patient medical records from April 2025 to March 2026. A total of 58 medical records met the study criteria. The results showed that 82.8% of cases involved DRPs. The most prevalent problem was P1.3 (untreated symptoms or indications) at 63.8%, with the primary cause being C4.1 (treatment duration too short), also at 63.8%. Ceftriaxone and gentamicin were the most commonly used antibiotics. A Chi-Square test revealed no significant association between diagnosis and antibiotic selection (p=0.963). These findings underscore the significant role of clinical pharmacists in overseeing antibiotic therapy for pediatric patients.

Keywords: Drug-Related Problems, PCNE V9.1, Pneumonia, Children, Antibiotics

INTRODUCTION

Pneumonia remains one of the leading causes of mortality among children under five years of age worldwide. According to the World Health Organization, pneumonia accounted for approximately 14% of all deaths among children under five, representing 740,180 deaths in 2019 (WHO, 2022). In Indonesia, pneumonia also remains a major cause of morbidity and mortality among infants and young children. The Indonesian Demographic and Health Survey reported a pneumonia prevalence of approximately 3.6 per 1,000 children under five, indicating that its prevention and clinical management still require substantial improvement (Ministry of Health of the Republic of Indonesia, 2021). The management of pneumonia in pediatric patients requires careful pharmacological consideration, particularly regarding antibiotic selection, dosage, route of administration, and duration of therapy. Pediatric patients have distinct pharmacokinetic characteristics compared with adults, including age-dependent differences in volume of distribution, hepatic enzyme activity, and renal clearance. These physiological variations may increase children's susceptibility to inappropriate

pharmacotherapy and medication-related errors (Kearns et al., 2003; Salunke et al., 2021). Consequently, pediatric patients are particularly vulnerable to Drug-Related Problems (DRPs), defined as events or circumstances involving pharmacotherapy that actually or potentially interfere with the achievement of optimal therapeutic outcomes (Strand et al., 1990).

Drug-Related Problems constitute an important patient-safety concern in contemporary clinical pharmacy practice. In pediatric pneumonia, DRPs may include inappropriate antibiotic selection, incorrect weight-based dosing, unsuitable routes of administration, inappropriate duration of antibiotic therapy, and unrecognized drug interactions. Such problems may result not only in therapeutic failure but also in antimicrobial resistance, prolonged hospitalization, adverse clinical outcomes, and increased healthcare costs (Fernández-Llamazares et al., 2022; Nguyen et al., 2021). Therefore, systematic identification of DRPs is essential to optimize antibiotic therapy and improve medication safety among pediatric patients with pneumonia. One of the most widely recognized frameworks for systematically identifying and classifying DRPs is the Pharmaceutical Care Network Europe (PCNE) classification system. PCNE Version 9.1 provides a hierarchical framework that classifies DRPs according to the identified problem, its underlying cause, and the interventions required to address it (Pharmaceutical Care Network Europe, 2020). Compared with earlier DRP classification approaches, PCNE V9.1 provides a more structured and reproducible framework for evaluating complex pharmacotherapy-related problems encountered in clinical practice. Its application is therefore particularly relevant for comprehensively assessing antibiotic-related problems in pediatric pneumonia.

Previous studies have identified a substantial burden of DRPs among pediatric patients with pneumonia. Nguyen et al. (2021) reported that 78.4% of pediatric pneumonia patients experienced DRPs, with inappropriate dosing identified as one of the predominant problems. Similarly, Ahmed et al. (2024) found that 65.3% of pneumonia patients in a teaching hospital experienced at least one DRP, with inappropriate drug selection emerging as a major contributing factor. In Indonesia, Monica et al. (2021) reported that inappropriate duration of antibiotic therapy was among the most frequently identified DRPs in pediatric bronchopneumonia. These findings demonstrate that DRPs remain a significant concern in pneumonia management; however, the type and frequency of DRPs may vary according to patient characteristics, prescribing practices, institutional policies, and clinical settings. Despite these findings, evidence regarding DRPs in pediatric pneumonia in Indonesia remains limited, particularly studies applying the PCNE V9.1 classification system in a structured manner. Furthermore, previous research has largely focused on general or teaching hospitals, while evidence from occupational health hospitals that also provide pediatric services remains scarce. This represents an important research gap because differences in institutional characteristics, patient populations, prescribing practices, and antibiotic management may influence the pattern and causes of DRPs. Accordingly, the present study extends the existing evidence by applying PCNE V9.1 to systematically identify and classify DRPs among pediatric pneumonia patients in a distinct occupational health hospital setting.

The Regional Occupational Health Hospital of West Java Province (RSUD Kesehatan Kerja Provinsi Jawa Barat) is a government-owned type C hospital that provides inpatient services for both occupationally affiliated populations and the general public, including pediatric patients. Pediatric inpatient care is provided in the Tampomas and Halimun wards. This institutional context provides a distinctive setting for evaluating pharmacotherapy-related problems and contributes additional evidence regarding the safety and appropriateness of antibiotic use in pediatric pneumonia. Therefore, this study aims to determine the prevalence of DRPs among pediatric patients with pneumonia, classify the identified DRPs according to PCNE V9.1, and analyze the association between pneumonia diagnosis and

antibiotic selection as potential determinants of DRP occurrence. The findings are expected to provide evidence for optimizing antibiotic therapy, strengthening pharmaceutical care, and improving medication safety among pediatric patients with pneumonia.

METHODS

This study employed a descriptive observational design with retrospective data collection. No intervention was administered to the study subjects, as all data were obtained exclusively from patients' medical records. The study population consisted of all pediatric patients aged 0–18 years who were hospitalized with a diagnosis of pneumonia or bronchopneumonia in the Tampomas and Halimun wards of the Regional Occupational Health Hospital of West Java Province (RSUD Kesehatan Kerja Provinsi Jawa Barat) between April 2025 and March 2026. Patients were included if they met the following criteria: (1) aged 0–18 years; (2) had a primary, working, or suspected diagnosis of pneumonia or bronchopneumonia; (3) received at least one antibiotic during hospitalization; and (4) had complete medical records containing essential information on patient characteristics, diagnosis, pharmacotherapy, body weight, and length of hospital stay. Patients were excluded if their medical records were incomplete or illegible or if they were transferred to another healthcare facility before completing treatment.

The sample size was initially determined using Slovin's formula with a 5% margin of error. Following the eligibility screening process, 58 medical records fulfilled all inclusion and exclusion criteria and were included in the final analysis. Data were systematically extracted from the medical records using a predefined data collection form. The collected variables comprised demographic characteristics, including sex, age in months, and body weight; clinical characteristics, including diagnosis, comorbidities, and length of hospital stay; and pharmacotherapy characteristics, including the generic name and pharmacological class of antibiotics, route of administration, prescribed dose, a nd duration of antibiotic therapy. The collected pharmacotherapy data were subsequently evaluated to identify Drug-Related Problems (DRPs) associated with antibiotic therapy. Each identified DRP was classified according to the Pharmaceutical Care Network Europe (PCNE) Classification for Drug-Related Problems Version 9.1, with particular attention to the problem and cause domains. The appropriateness of antibiotic therapy was assessed by comparing the prescribed antibiotic regimen with relevant pediatric pneumonia treatment guidelines, considering antibiotic selection, weight-based dosage, route of administration, and duration of therapy.

To ensure consistency in the assessment, several key terms were operationally defined. *Drug-Related Problems* (DRPs) were defined as events or circumstances involving pharmacotherapy that actually or potentially interfere with the achievement of desired health outcomes and were identified and classified using the *Pharmaceutical Care Network Europe* (PCNE) Classification for Drug-Related Problems Version 9.1. Dose appropriateness was defined as the agreement between the prescribed antibiotic dose and the recommended dose, calculated in mg/kg body weight/day, according to the *British National Formulary for Children* (BNFc, 2023) and the Indonesian National Formulary, considering the patient's age and body weight. A prescribed dose was considered inappropriate when it fell outside the recommended therapeutic range. The appropriateness of treatment duration was determined by comparing the documented duration of antibiotic therapy with the recommendations of the Indonesian Pediatric Society (IDAI, 2016). Antibiotic therapy was considered appropriate when administered for 5–7 days for mild-to-moderate pneumonia and 10–14 days for severe pneumonia. Treatment duration was classified as inadequate when it was shorter than the minimum recommended duration without documentation of continued oral antibiotic therapy after hospital discharge. The severity of pneumonia was classified as mild-to-moderate or

severe according to the clinical criteria recommended by IDAI (2016), including signs of respiratory distress, oxygen saturation, and the presence of general danger signs in children.

DRPs were identified by systematically evaluating each patient's antibiotic therapy against relevant clinical and pharmacotherapeutic guidelines, including the pediatric pneumonia management guidelines issued by the Indonesian Pediatric Society (IDAI, 2016), the *British National Formulary for Children* (BNFc, 2023), and the Indonesian National Formulary. Antibiotic dose appropriateness was assessed primarily using the patient's documented actual body weight. When body weight was unavailable, estimated body weight based on the Behrman formula was used. The appropriateness of treatment duration was evaluated according to IDAI and BNFc recommendations, taking into account pneumonia severity and the antibiotic administered. Each identified pharmacotherapy discrepancy was subsequently evaluated and classified using PCNE V9.1. DRPs were categorized according to the problem domains (P codes: P1–P3) and cause domains (C codes: C1–C9). The classification process was independently performed by the researcher and subsequently reviewed by a clinical supervisor from the hospital pharmacy team to improve consistency and reliability of the assessment. Disagreements in classification were resolved through discussion and consensus between the assessors.

Descriptive statistical analysis was performed to summarize the study variables. Categorical variables were presented as frequencies and percentages, whereas continuous variables, including age and length of hospital stay, were summarized according to their distribution. The normality of continuous variables was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Bivariate analysis using Pearson's chi-square test was performed to evaluate the association between diagnostic category and antibiotic selection. Statistical significance was defined as a p-value < 0.05. All statistical analyses were performed using SPSS version 27.0. This study received ethical approval and authorization to access patients' medical records from the Regional Occupational Health Hospital of West Java Province (*RSUD Kesehatan Kerja Provinsi Jawa Barat*). Patient confidentiality was maintained throughout the study by using medical record data solely for research purposes and excluding personally identifiable information from the analysis.

RESULTS AND DISCUSSION

Patient Demographic Characteristics

A total of 58 pediatric patients diagnosed with pneumonia or bronchopneumonia were included in this study. Of these, 37 patients (63.8%) were male and 21 (36.2%) were female, corresponding to a male-to-female ratio of 1.76:1 (Table 1).

Table 1. Distribution of Patients by Sex

Sex	Frequency (n)	Percentage (%)
Male	37	63.8
Female	21	36.2
Total	**58**	**100.0**

The age distribution of the patients is presented in Table 2. Most patients were aged 1–4 years (51.7%, n = 30), followed by infants aged <1 year (39.7%, n = 23). Only five patients (8.6%) were aged ≥5 years. Overall, 91.4% of the study population consisted of children younger than five years.

Table 2. Distribution of Patients by Age Group

Age Group	Frequency (n)	Percentage (%)
<1 year	23	39.7
1–4 years	30	51.7
5–9 years	3	5.2

10–14 years	1	1.7
≥15 years	1	1.7
Total	**58**	**100.0**

Normality testing of age in months using the Kolmogorov–Smirnov and Shapiro–Wilk tests indicated that age was not normally distributed ($p < 0.001$). Therefore, the age distribution of the study population was predominantly concentrated in the younger pediatric age groups.

Distribution of Diagnoses

The distribution of diagnoses among the 58 pediatric patients is presented in Table 3. Pure bronchopneumonia was the most frequently recorded diagnosis, accounting for 35 cases (60.3%). This was followed by suspected bronchopneumonia in eight patients (13.8%) and bronchopneumonia with comorbidities in seven patients (12.1%). Bronchopneumonia accompanied by asthma or probable asthma was identified in five patients (8.6%). In contrast, pneumonia or suspected pneumonia and pneumonia with comorbidities were recorded in two (3.4%) and one (1.7%) patients, respectively.

Table 3. Distribution of Patient Diagnoses

Diagnostic Category	Frequency (n)	Percentage (%)
Pneumonia / Suspected Pneumonia	2	3.4
Pneumonia with Comorbidities	1	1.7
Bronchopneumonia	35	60.3
Suspected Bronchopneumonia	8	13.8
Bronchopneumonia with Asthma/Probable Asthma	5	8.6
Bronchopneumonia with Comorbidities	7	12.1
Total	**58**	**100.0**

Overall, bronchopneumonia and its associated diagnostic categories accounted for 55 of the 58 cases (94.8%), whereas pneumonia and its associated categories accounted for three cases (5.2%). These findings demonstrate that bronchopneumonia constituted the predominant diagnostic category among the pediatric patients included in this study.

Antibiotic Utilization Patterns

The distribution of antibiotic use according to generic name is presented in Table 4. Gentamicin was the most frequently prescribed antibiotic, accounting for 29 patients (50.0%), followed by ceftriaxone in 18 patients (31.0%) and cefixime in eight patients (13.8%). Ampicillin/sulbactam and cefotaxime were less frequently prescribed, accounting for two (3.4%) and one (1.7%) patients, respectively.

Table 4. Distribution of Antibiotic Use by Generic Name

Generic Antibiotic	Frequency (n)	Percentage (%)
Gentamicin	29	50.0
Ceftriaxone	18	31.0
Cefixime	8	13.8
Ampicillin/Sulbactam	2	3.4
Cefotaxime	1	1.7
Total	**58**	**100.0**

The routes of antibiotic administration are presented in Table 5. Intravenous administration was the predominant route, recorded in 48 patients (82.8%), followed by oral administration in six patients (10.3%). Parenteral and subcutaneous administration were each recorded in two patients (3.4%).

Table 5. Distribution of Antibiotic Administration Routes

Route of Administration	Frequency (n)	Percentage (%)
Intravenous	48	82.8
Oral	6	10.3
Parenteral	2	3.4
Subcutaneous	2	3.4
Total	**58**	**100.0**

Overall, the antibiotic utilization pattern was predominantly characterized by gentamicin and ceftriaxone use, which together accounted for 81.0% of the antibiotics prescribed. Intravenous administration was the most commonly documented route of antibiotic delivery.

Length of Hospital Stay

The distribution of length of hospital stay is presented in Table 6. The most common duration of hospitalization was three days, recorded in 26 patients (44.8%), followed by four days in 14 patients (24.1%). Six patients (10.3%) were hospitalized for six days, while only one patient (1.7%) had a hospital stay of seven days.

Table 6. Distribution of Length of Hospital Stay

Length of Stay (days)	Frequency (n)	Percentage (%)
1	5	8.6
2	4	6.9
3	26	44.8
4	14	24.1
5	2	3.4
6	6	10.3
7	1	1.7
Total	**58**	**100.0**

The median length of hospital stay was 3 days, with a range of 1–7 days. Normality testing using both the Kolmogorov–Smirnov and Shapiro–Wilk tests indicated that the length-of-stay data were not normally distributed ($p < 0.001$). Therefore, the median and range were considered more appropriate measures for describing the distribution of hospitalization duration.

Association Between Diagnosis and Antibiotic Selection

The association between diagnostic category and antibiotic selection was evaluated using Pearson's chi-square test. As presented in Table 7, the analysis yielded a Pearson chi-square value of $\chi^2 = 13.187$ with 24 degrees of freedom and a p-value of 0.963. Thus, no statistically significant association was observed between diagnostic category and antibiotic selection ($p > 0.05$). The likelihood ratio test similarly showed no statistically significant association ($\chi^2 = 13.786$, df = 24, $p = 0.951$). The linear-by-linear association was also not statistically significant ($\chi^2 = 1.493$, df = 1, $p = 0.222$).

Table 7. Chi-Square Analysis of the Association Between Diagnosis and Antibiotic Selection

Statistical Test	Value	df	*p*-value	Interpretation
Pearson Chi-Square	13.187	24	0.963	Not significant
Likelihood Ratio	13.786	24	0.951	Not significant
Linear-by-Linear Association	1.493	1	0.222	Not significant
Valid Cases (N)	58	–	–	–

However, interpretation of the Pearson chi-square result requires caution because 91.4% of the cells in the contingency table had expected counts below five. This condition indicates that the assumptions underlying the chi-square test were not adequately satisfied. Therefore, although the analysis did not demonstrate a statistically significant association between diagnosis and antibiotic selection, this finding should be interpreted cautiously.

Identification and Classification of Drug-Related Problems According to PCNE V9.1

Among the 58 pediatric patients evaluated, 48 (82.8%) experienced at least one identified *Drug-Related Problem* (DRP), whereas 10 patients (17.2%) had no identified DRP. The distribution of DRPs according to the problem domains of the PCNE V9.1 classification is presented in Table 8.

Table 8. Distribution of DRPs According to PCNE V9.1 Problem Domains

PCNE V9.1 Code	Description	Frequency (n)	Percentage (%)
No DRP	No drug-related problem identified	10	17.2
P1.1	No effect of drug treatment despite correct use	3	5.2
P2.1	Adverse drug event (possibly) occurring	5	8.6
P1.3	Untreated symptoms or indication	37	63.8
P1.2	Effect of drug treatment not optimal	1	1.7
P1.3	Untreated symptoms or indication	2	3.4
Total		**58**	**100.0**

The most frequently identified problem domain was P1.3 (*untreated symptoms or indication*). Thirty-seven cases (63.8%) were assigned to this category in association with inadequate treatment duration, while an additional two cases (3.4%) involved an identified indication that was not adequately treated. When combined, P1.3 accounted for 39 cases (67.2%). P2.1, representing a possible adverse drug event, was identified in five patients (8.6%), all of whom received gentamicin. P1.1 (*no effect of drug treatment despite correct use*) was identified in three patients (5.2%), whereas P1.2 (*effect of drug treatment not optimal*) occurred in one patient (1.7%). The underlying causes of the identified DRPs were subsequently classified according to the PCNE V9.1 cause domains, as shown in Table 9.

Table 9. Distribution of DRPs According to PCNE V9.1 Cause Domains

PCNE V9.1 Code	Description	Frequency (n)	Percentage (%)
No DRP	No DRP-related cause identified	10	17.2
C1.1	Inappropriate drug according to guidelines/formulary	3	5.2
C3.2	Dose of a single active ingredient too high	5	8.6
C4.1	Duration of treatment too short	37	63.8
C6.6	Drug administered via an inappropriate route by a healthcare professional	2	3.4
C1.5	No or incomplete drug treatment despite an existing indication	1	1.7
Total		**58**	**100.0**

The predominant cause of DRPs was C4.1 (*duration of treatment too short*), which was identified in 37 patients (63.8%). This finding corresponded to the predominance of treatment-duration-related problems identified in the problem domain. The second most frequent cause was C3.2 (*dose of a single active ingredient too high*), identified in five patients (8.6%). C1.1 (*inappropriate drug according to guidelines or formulary*) was identified in three patients (5.2%), followed by C6.6 (*drug administered via an inappropriate route by a healthcare professional*) in two patients (3.4%) and C1.5 (*no or incomplete drug*

treatment despite an existing indication) in one patient (1.7%). Overall, the findings indicate that DRPs were identified in more than four-fifths of the pediatric pneumonia and bronchopneumonia cases evaluated, with an inadequately short duration of antibiotic therapy representing the most frequently identified cause.

DISCUSSION

Patient Demographic Characteristics

Male patients predominated in this study, accounting for 63.8% of the study population, with a male-to-female ratio of 1.76:1. This finding is consistent with previous studies reporting a higher proportion of male children among pediatric pneumonia patients. Monica et al. (2021) reported that 57.5% of pediatric pneumonia patients at Dr. Hasan Sadikin General Hospital, Bandung, were male, while Nguyen et al. (2021) reported a male proportion of 61.2% in Vietnam. This predominance may be associated with sex-related differences in immune maturation and respiratory tract development, which may influence susceptibility to lower respiratory tract infections during early childhood (Muenchhoff & Goulder, 2014). Sex-related differences in X-linked immune responses and respiratory development have also been proposed as biological mechanisms contributing to the higher susceptibility of boys to respiratory infections (Nino et al., 2018; Regis et al., 2021).

Most patients were aged 1–4 years (51.7%), followed by those aged <1 year (39.7%). Overall, 91.4% of patients were younger than five years. This finding is consistent with the epidemiological profile of pediatric pneumonia, in which children under five, particularly infants and younger children, represent a highly susceptible population. Immaturity of humoral and cellular immunity, smaller airway diameter, and limited respiratory defense mechanisms may increase susceptibility to lower respiratory tract infections in this age group (Rudan et al., 2013; Selvi & Sasi Vaithilingan, 2024). Environmental and host-related factors, including nutritional status, low birth weight, incomplete immunization, lack of exclusive breastfeeding, exposure to household air pollution, and overcrowding, may further increase the risk of pneumonia among young children (Rosmawati et al., 2024; Selvi & Sasi Vaithilingan, 2024).

Distribution of Diagnoses

Bronchopneumonia and its associated diagnostic categories accounted for 94.8% of all cases, indicating that bronchopneumonia was the predominant clinical diagnosis in this study. In young children, the relatively narrow bronchioles and developing respiratory system may facilitate peribronchial spread of infection, contributing to a bronchopneumonic pattern rather than a localized lobar pattern. Clinically, distinguishing bacterial from viral pneumonia may also be challenging because signs and symptoms frequently overlap. This diagnostic uncertainty often results in empirical antibiotic therapy, particularly among hospitalized children. Comorbidities, including asthma or probable asthma, were identified in a proportion of patients and may complicate clinical management because additional respiratory conditions can influence symptoms, treatment requirements, and clinical outcomes. Therefore, antibiotic selection should not rely solely on the diagnostic label but should also consider disease severity, age, comorbidities, clinical presentation, and, when available, microbiological findings.

Antibiotic Utilization Patterns

Gentamicin was the most frequently prescribed antibiotic (50.0%), followed by ceftriaxone (31.0%), cefixime (13.8%), ampicillin/sulbactam (3.4%), and cefotaxime (1.7%). Third-generation cephalosporins, including ceftriaxone, cefixime, and cefotaxime, collectively accounted for 46.5% of antibiotic use. The predominance of gentamicin and

third-generation cephalosporins reflects the use of broad-spectrum empirical therapy for hospitalized pediatric patients with pneumonia or bronchopneumonia. The high frequency of gentamicin use requires particular attention because aminoglycosides have a narrow therapeutic index and are associated with nephrotoxicity and ototoxicity. These risks are particularly relevant in neonates and young infants because renal function and drug clearance vary considerably with age. The *British National Formulary for Children* recommends appropriate weight- and age-based dosing and therapeutic monitoring when clinically indicated to minimize aminoglycoside toxicity (BNFc, 2023). Therefore, appropriate dose calculation and monitoring are important components of pharmaceutical care in pediatric patients receiving gentamicin.

Ceftriaxone was the second most frequently prescribed antibiotic. Although it provides broad antibacterial coverage and convenient dosing, its use requires special consideration in neonates, particularly those with hyperbilirubinemia or those receiving calcium-containing intravenous solutions. Cefotaxime may be considered an alternative in certain neonatal circumstances because it has a lower risk of bilirubin displacement (BNFc, 2023). Cefixime, an oral third-generation cephalosporin, may be used as oral continuation or *step-down therapy* when clinically appropriate, whereas ampicillin/sulbactam provides broader coverage against beta-lactamase-producing organisms. Intravenous administration was the predominant route (82.8%), which is consistent with the inpatient setting and the need for reliable systemic antibiotic exposure in children requiring hospitalization. However, the presence of subcutaneous administration in two patients (3.4%) requires careful evaluation because this is not a conventional route for the antibiotics identified in this study. These cases contributed to the identification of administration-related DRPs and highlight the importance of verifying the prescribed and documented routes of antibiotic administration.

Length of Hospital Stay and Duration of Antibiotic Therapy

The median length of hospital stay was three days, with most patients hospitalized for three (44.8%) or four days (24.1%). This finding is clinically relevant when considered alongside the recommended duration of antibiotic therapy. According to the IDAI guideline used in this study, antibiotic therapy generally extends beyond the hospitalization period for many patients, depending on pneumonia severity and clinical response (IDAI, 2016).
Consequently, a short hospital stay does not necessarily indicate an inadequate total duration of antibiotic therapy if treatment is appropriately continued after discharge. However, the retrospective medical records evaluated in this study did not consistently document oral continuation therapy or *discharge planning*. Based on the predefined operational criteria, the absence of such documentation resulted in several cases being classified as having an inadequately short treatment duration. This issue should therefore be interpreted as both a potential pharmacotherapy problem and a limitation related to the completeness of medical record documentation.

Association Between Diagnosis and Antibiotic Selection

No statistically significant association was observed between diagnostic category and antibiotic selection ($\chi^2 = 13.187$; $p = 0.963$). This finding suggests that antibiotic selection did not differ substantially across the diagnostic categories included in the analysis. One possible explanation is that empirical antibiotic treatment was determined more strongly by overall clinical presentation and local prescribing practices than by the specific diagnostic category of pneumonia or bronchopneumonia. Nevertheless, this finding should be interpreted cautiously because 91.4% of the cells in the contingency table had expected counts below five, indicating that the assumptions of Pearson's chi-square test were not adequately satisfied. The absence of statistical significance should therefore not be interpreted as

definitive evidence that diagnosis has no relationship with antibiotic selection. Studies with larger sample sizes and more appropriate category distributions are required to confirm this association.

Identification and Classification of Drug-Related Problems

DRPs were identified in 48 of the 58 patients (82.8%), indicating a substantial burden of pharmacotherapy-related problems in the study population. This prevalence was higher than those reported by Ahmed et al. (2024), Nguyen et al. (2021), and Monica et al. (2021), who reported DRP prevalences of 65.3%, 78.4%, and 71.3%, respectively. Differences across studies may be attributable to variations in patient characteristics, clinical settings, prescribing practices, documentation quality, and the DRP classification systems applied.

The most prominent DRP-related finding concerned treatment duration. The cause domain C4.1 (*duration of treatment too short*) was identified in 37 patients (63.8%). These cases were primarily identified because the documented duration of antibiotic treatment was shorter than the duration specified in the clinical criteria used in this study and no continuation of oral antibiotic therapy after discharge was documented. Similar concerns regarding inappropriate antibiotic duration have been reported in previous studies of pediatric pneumonia (Hastuti et al., 2020; Monica et al., 2021).

However, this finding should be interpreted carefully. Because this study was retrospective, the absence of documented post-discharge therapy does not necessarily establish that treatment was actually discontinued. Some patients may have received oral antibiotics after discharge without complete documentation in the medical records reviewed. Consequently, the high proportion of duration-related DRPs may partly reflect limitations in documentation rather than confirmed clinical undertreatment. This finding emphasizes the importance of comprehensive medication reconciliation and documentation of discharge medication plans.

Excessive dosing (C3.2) was identified in five patients (8.6%), predominantly involving gentamicin. This finding is clinically important because gentamicin dosing in pediatric patients requires careful adjustment according to body weight, age, renal function, and dosing interval. Excessive exposure may increase the risk of nephrotoxicity and ototoxicity. Therefore, systematic dose verification and appropriate monitoring should be prioritized in pediatric patients receiving aminoglycosides.

Inappropriate drug selection according to guidelines or formulary criteria (C1.1) was identified in three patients (5.2%). Particular attention is warranted when ceftriaxone is considered for neonates or young infants because age, bilirubin status, concomitant intravenous therapy, and other relevant clinical factors should be evaluated before administration. Administration-related problems (C6.6) were identified in two patients (3.4%), reflecting the documented use of an inappropriate route. In addition, incomplete or absent treatment despite an identified indication (C1.5) was observed in one patient (1.7%).

Collectively, these findings indicate that the principal opportunities for improving pharmaceutical care in pediatric pneumonia at this hospital involve ensuring appropriate antibiotic duration, strengthening weight-based dose verification, reviewing antibiotic selection in high-risk pediatric groups, verifying routes of administration, and improving documentation of post-discharge antibiotic therapy. The application of PCNE V9.1 enabled these problems to be systematically categorized and may support more targeted clinical pharmacy interventions to improve the safety and effectiveness of antibiotic therapy.

CONCLUSIONS

Conclusion

This study identified and classified Drug-Related Problems (DRPs) in 82.8% of 58 pediatric patients with pneumonia or bronchopneumonia at the Regional Occupational Health Hospital of West Java Province using the PCNE V9.1 classification system. The predominant DRP was P1.3 (untreated symptoms or indications), identified in 63.8% of patients, with C4.1 (duration of treatment too short) as the most frequently identified cause. Gentamicin was the most commonly prescribed antibiotic (50.0%), followed by ceftriaxone (31.0%), while intravenous administration was the predominant route (82.8%). No statistically significant association was observed between diagnostic category and antibiotic selection ($\chi^2 = 13.187$; $p = 0.963$), although this finding should be interpreted cautiously due to the limitations of the chi-square assumptions. The high prevalence of DRPs related to treatment duration highlights the need to strengthen documentation of discharge planning, implement a structured antimicrobial stewardship program, and enhance the role of clinical pharmacists in monitoring antibiotic therapy among pediatric patients with pneumonia. Further prospective, multicenter studies incorporating broader clinical data, including microbiological culture and antimicrobial susceptibility results, are recommended to validate these findings and improve their generalizability.

Limitations

This study has several limitations. First, its retrospective observational design made DRP identification highly dependent on the completeness and accuracy of medical record documentation. In particular, inconsistent documentation of post-discharge antibiotic therapy may have resulted in an overestimation of DRPs related to insufficient treatment duration. Second, the relatively small sample size (n = 58) resulted in 91.4% of the contingency-table cells having expected counts below five, limiting the reliability of the chi-square analysis of the association between diagnosis and antibiotic selection. Third, this was a single-center study conducted at the Regional Occupational Health Hospital of West Java Province; therefore, the findings may not be generalizable to hospitals with different patient populations or prescribing practices. Fourth, the absence of microbiological culture and antimicrobial susceptibility data limited the assessment of empirical antibiotic appropriateness in relation to local pathogen and resistance patterns. Finally, inconsistent availability of Therapeutic Drug Monitoring data limited a comprehensive assessment of gentamicin exposure and its potential toxicity, particularly among neonates and young infants.

Recommendations

Future studies should involve larger sample sizes, longer observation periods, and multicenter settings to improve the representativeness and generalizability of the findings. A prospective study design is recommended to enable more accurate identification and monitoring of Drug-Related Problems (DRPs), particularly those related to antibiotic dosage, treatment duration, adverse drug events, and clinical outcomes. Future research should also incorporate microbiological culture and antimicrobial susceptibility data, renal function parameters, Therapeutic Drug Monitoring for aminoglycosides such as gentamicin, and complete documentation of post-discharge antibiotic therapy. In addition, evaluating the impact of clinical pharmacist interventions and structured antimicrobial stewardship programs may provide stronger evidence for strategies to reduce DRPs and improve the safety and effectiveness of antibiotic therapy in pediatric patients with pneumonia.

Author Contributions

All authors made substantial contributions to the conception and development of this study. Their contributions included study conceptualization and design, development of the theoretical and methodological framework, data collection, data analysis, interpretation of the

findings, manuscript preparation, and critical revision for important intellectual content. All authors participated in reviewing the manuscript and approved the final version for publication. All authors also agreed to be accountable for the accuracy and integrity of the work.

REFERENCES

Ahmed, R., Khan, M. A., & Nasim, A. (2024). Drug-related problems in pediatric pneumonia patients: A cross-sectional study at a tertiary care hospital in Pakistan. Journal of Pharmaceutical Policy and Practice, 17(1), 45–53. https://doi.org/10.1186/s40545-024-00608-0

British National Formulary for Children. (2023). BNF for children 2023–2024. BMJ Publishing Group & Royal Pharmaceutical Society.

Chamekh, M., Deny, M., Romano, M., Lundgren, F., Vandenhole, M., Govaerts, I., ... Corazza, F. (2017). Differential susceptibility to infectious respiratory diseases between males and females linked to sex-specific innate immune inflammatory response. Frontiers in Immunology, 8, 1806. https://doi.org/10.3389/fimmu.2017.01806

Fernández-Llamazares, C. M., García-Iglesias, M. A., & Hurtado Ruz, S. (2022). Drug-related problems in hospitalized pediatric patients: A systematic review. Frontiers in Pediatrics, 10, 876987. https://doi.org/10.3389/fped.2022.876987

Greenwood, P. E., & Nikulin, M. S. (1996). A guide to chi-squared testing. John Wiley & Sons.

Hastuti, D. P., Ikawati, Z., & Irijanto, F. (2020). Identifikasi drug related problems pada pasien bronkopneumonia anak di RSUP Dr. Sardjito Yogyakarta. Majalah Farmaseutik, 16(1), 31–40. https://doi.org/10.22146/farmaseutik.v16i1.50432

Ikatan Dokter Anak Indonesia. (2016). Panduan tatalaksana pneumonia pada anak. Badan Penerbit Ikatan Dokter Anak Indonesia.

Kearns, G. L., Abdel-Rahman, S. M., Alander, S. W., Blowey, D. L., Leeder, J. S., & Kauffman, R. E. (2003). Developmental pharmacology—Drug disposition, action, and therapy in infants and children. The New England Journal of Medicine, 349(12), 1157–1167. https://doi.org/10.1056/NEJMra035092

Kementerian Kesehatan Republik Indonesia. (2016). Peraturan Menteri Kesehatan Republik Indonesia Nomor 72 Tahun 2016 tentang standar pelayanan kefarmasian di rumah sakit. Kementerian Kesehatan Republik Indonesia.

Kementerian Kesehatan Republik Indonesia. (2021). Profil kesehatan Indonesia tahun 2020. Kementerian Kesehatan Republik Indonesia.

Monica, R., Kartika, A. M., & Putra, O. N. (2021). Identifikasi drug related problems pada pasien bronkopneumonia anak di RSUP Dr. Hasan Sadikin Bandung periode 2019–2020. Jurnal Farmasi Klinik Indonesia, 10(3), 187–196. https://doi.org/10.15416/ijcp.2021.10.3.187

Muenchhoff, M., & Goulder, P. J. R. (2014). Sex differences in pediatric infectious diseases. The Journal of Infectious Diseases, 209(Suppl. 3), S120–S126. https://doi.org/10.1093/infdis/jiu232

Nguyen, T. T., Nguyen, H. T., & Le, V. T. (2021). Drug-related problems in pediatric patients with pneumonia at a Vietnamese tertiary hospital: A prospective observational study. Pharmacy, 9(4), 178. https://doi.org/10.3390/pharmacy9040178

Nino, C. L., Perez, G. F., Isaza, N., Gutierrez, M. J., & Nino, G. (2018). Characterization of sex-based DNA methylation signatures in the airways during early life. Scientific Reports, 8(1), 5652. https://doi.org/10.1038/s41598-018-23063-5

Pharmaceutical Care Network Europe. (2020). PCNE classification for drug-related problems V9.1. PCNE Working Group. https://www.pcne.org/upload/files/415_PCNE_classification_V9-1.pdf

Regis, E., Fontanella, S., Lin, L., Howard, R., Haider, S., Curtin, J. A., Edwards, M. R., Rattray, M., Simpson, A., Custovic, A., & Johnston, S. L. (2021). Sex differences in innate anti-viral immune responses to respiratory viruses and in their clinical outcomes in a birth cohort study. Scientific Reports, 11, 23741. https://doi.org/10.1038/s41598-021-03044-x

Rosmawati, Windari, F., Anggraini, H., & Ningsih, T. R. (2024). Faktor risiko pneumonia pada balita. Jurnal Ners Universitas Pahlawan, 8(2), 1765–1775.

Rudan, I., O'Brien, K. L., Nair, H., Liu, L., Theodoratou, E., Qazi, S., Johnson, H. L., Black, R. E., Campbell, H., & Child Health Epidemiology Reference Group. (2013). Epidemiology and etiology of childhood pneumonia in 2010: Estimates of incidence, severe morbidity, mortality, underlying risk factors and causative pathogens for 192 countries. Journal of Global Health, 3(1), 010401. https://doi.org/10.7189/jogh.03.010401

Salunke, S., Brandys, B., Giacoia, G., & Tuleu, C. (2013). The STEP (Safety and Toxicity of Excipients for Paediatrics) database: Part 2—The pilot version. International Journal of Pharmaceutics, 457(1), 310–322. https://doi.org/10.1016/j.ijpharm.2013.09.013

Selvi, M., & Sasi Vaithilingan. (2024). Childhood pneumonia in low- and middle-income countries: A systematic review of prevalence, risk factors, and healthcare-seeking behaviors. Cureus, 16(4), e57636. https://doi.org/10.7759/cureus.57636

Setiawan, A., & Rahmawati, I. (2021). Faktor jenis kelamin dan kejadian pneumonia pada balita. Jurnal Epidemiologi Kesehatan Indonesia, 5(2), 90–97.

Strand, L. M., Morley, P. C., Cipolle, R. J., Ramsey, R., & Lamsam, G. D. (1990). Drug-related problems: Their structure and function. DICP: The Annals of Pharmacotherapy, 24(11), 1093–1097. https://doi.org/10.1177/106002809002401114

World Health Organization. (2022). Pneumonia in children. WHO.