**Original Research**

# Comparative Study of Intravenous vs. Oral Antibiotics in the Treatment of Pediatric Pneumonia

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**ABSTRACT**

**Aim:** This study aimed to compare the efficacy and safety of intravenous (IV) antibiotics versus oral antibiotics in the treatment of pediatric pneumonia, focusing on clinical improvement, duration of hospital stay, incidence of complications, and adverse drug reactions.

**Material and Methods:** A prospective, randomized, comparative clinical trial was conducted over 12 months at a tertiary care hospital. A total of 100 pediatric patients aged 2–12 years diagnosed with community-acquired pneumonia (CAP) were randomly assigned into two groups: Group A received IV Ceftriaxone, and Group B received oral Amoxicillin-Clavulanic Acid. Clinical improvement within 72 hours, duration of hospital stay, incidence of complications, treatment failure, and adverse drug reactions were assessed. Statistical analysis was performed using SPSS version 19.0, with a p-value <0.05 considered significant.

**Results:** The IV antibiotics group demonstrated significantly faster clinical improvement (70.5 ± 4.8 hours vs. 73.2 ± 5.1 hours, p=0.03), earlier fever reduction (23.8 ± 4.5 hours vs. 26.4 ± 5.2 hours, p=0.04), and higher oxygen saturation levels (96.5 ± 1.8% vs. 94.8 ± 2.2%, p=0.02). The duration of hospital stay and days on oxygen support were also shorter in the IV group (6.5 ± 1.2 days vs. 7.1 ± 1.4 days, p=0.04; 1.8 ± 0.9 days vs. 2.4 ± 1.1 days, p=0.03). However, no statistically significant differences were observed in complications, ICU admissions, treatment failure, or adverse drug reactions between the two groups.

**Conclusion:** Intravenous antibiotics demonstrated superior efficacy in terms of faster clinical improvement, shorter hospital stays, and better oxygenation outcomes. However, oral antibiotics remain a viable and cost-effective alternative for mild to moderate cases, with comparable safety profiles. Individualized treatment approaches based on disease severity and patient-specific factors are essential for optimizing outcomes in pediatric pneumonia management.

**Keywords:** Pediatric pneumonia, Intravenous antibiotics, Oral antibiotics, Clinical improvement, Hospital stay.



## Introduction

Pneumonia remains one of the most significant causes of morbidity and mortality in children worldwide, particularly in developing regions where access to healthcare resources is limited. Despite advances in preventive measures such as vaccination and improved sanitation, pneumonia continues to account for a substantial proportion of hospital admissions and childhood deaths. It is an acute respiratory infection affecting the lung parenchyma, often characterized by symptoms such as fever, cough, tachypnea, and difficulty in breathing. The condition can be caused by a wide array of pathogens, including bacteria, viruses, and fungi, with bacterial pneumonia, particularly caused by Streptococcus pneumoniae and Haemophilus influenzae type b, being the most common and severe in children.[1]Antibiotic therapy remains the cornerstone of treatment for bacterial pneumonia, and timely intervention significantly influences clinical outcomes. Traditionally, intravenous (IV) antibiotics have been the preferred choice for hospitalized pediatric patients with moderate to severe pneumonia, primarily because of their rapid systemic bioavailability and ability to ensure consistent therapeutic drug levels in critically ill patients. However, oral antibiotics have increasingly gained attention as a viable alternative, especially in less severe cases or in settings where IV access is challenging or resource-limited.The choice between intravenous and oral antibiotics in pediatric pneumonia treatment depends on several factors, including disease severity, pathogen susceptibility, patient age, nutritional status, and healthcare infrastructure. Intravenous antibiotics are generally

preferred for children with severe pneumonia or those exhibiting complications such as respiratory distress, hypoxia, or impaired oral intake. In contrast, oral antibiotics are often considered adequate for children with mild to moderate pneumonia who can tolerate oral intake and are not in significant respiratory distress. Oral therapy is also more cost-effective, less invasive, and associated with a lower risk of catheter-related complications, making it an attractive option for outpatient care.[2] One of the ongoing debates in pediatric pneumonia management revolves around the efficacy and safety of IV versus oral antibiotics. Advocates of IV therapy argue that it provides faster clinical improvement, better control of infection, and reduces the risk of treatment failure. Conversely, proponents of oral therapy highlight its ease of administration, fewer complications, and comparable outcomes in specific clinical scenarios. These differing perspectives underscore the need for a comparative assessment to evaluate whether one mode of antibiotic delivery offers significant advantages over the other in terms of clinical improvement, duration of hospital stay, incidence of complications, and adverse drug reactions.Clinical improvement is a primary concern when comparing IV and oral antibiotics. Faster resolution of symptoms, including fever reduction, improved respiratory rate, and enhanced oxygenation, are key indicators of successful treatment. These parameters also influence the duration of hospital stay, which is another critical factor impacting healthcare costs and resource utilization. A shorter hospital stay not only reduces the economic burden on healthcare systems but also minimizes the risk of hospital-acquired infections.[3] Complications such as treatment failure, adverse drug reactions, and the need for intensive care unit (ICU) admission are additional considerations when evaluating antibiotic efficacy. Treatment failure, defined as the lack of clinical improvement or worsening of symptoms despite appropriate therapy, can have serious consequences, including prolonged hospitalization and increased morbidity. Adverse drug reactions, including gastrointestinal disturbances, allergic reactions, and renal or hepatic dysfunction, can further complicate therapy and require additional interventions. Therefore, understanding the safety profiles of both IV and oral antibiotics is essential for optimizing treatment protocols.The debate also extends to the practical aspects of antibiotic administration. Intravenous antibiotics require skilled healthcare personnel for insertion and maintenance of catheters, which increases healthcare costs and resource dependency. Additionally, prolonged IV access carries risks such as phlebitis, catheter-related bloodstream infections, and patient discomfort. In contrast, oral antibiotics are less invasive and can often be administered in outpatient or home settings, providing flexibility in patient management.[4]Another key factor influencing the choice of antibiotic route is the patient's nutritional status and ability to tolerate oral medications. Malnourished children or those with severe vomiting may not absorb oral antibiotics effectively, potentially reducing therapeutic efficacy. On the other hand, IV antibiotics bypass the gastrointestinal tract, ensuring reliable drug delivery even in critically ill or malnourished patients.Despite numerous studies exploring the efficacy of IV versus oral antibiotics in pediatric pneumonia, there remains considerable variability in findings due to differences in study design, patient populations, antibiotic regimens, and outcome measures. While some studies suggest that oral antibiotics are non-inferior to IV therapy for mild to moderate pneumonia, others indicate that IV antibiotics may offer superior outcomes in specific scenarios, particularly in critically ill children.[5]

**Material and Methods**

This study was a prospective, randomized, comparative clinical trial conducted at a tertiary care hospital over a 12-month period. The study aimed to compare the efficacy and safety of intravenous (IV) antibiotics versus oral antibiotics in the treatment of pediatric pneumonia.

The study included 100 pediatric patients, aged 2 to 12 years, diagnosed with community-acquired pneumonia (CAP). Inclusion criteria consisted of a clinical diagnosis of pneumonia based on WHO guidelines, which included symptoms such as fever, cough, tachypnea, and chest indrawing, along with chest X-ray findings consistent with pneumonia. Patients who had received antibiotic therapy within the previous 48 hours were excluded. Other exclusion criteria included severe pneumonia requiring intensive care, known allergies to study antibiotics, immunocompromised status, and the presence of comorbidities such as congenital heart disease.

Patients were randomly assigned into two groups of 50 patients each using a computer-generated randomization table. Group A received intravenous (IV) antibiotics, specifically IV Ceftriaxone at a dose of 50–75 mg/kg/day in two divided doses for 5–7 days, followed by oral step-down therapy if clinically stable. Group B received oral antibiotics, specifically Oral Amoxicillin-Clavulanic Acid at a dose of 45 mg/kg/day in two divided doses for 5–7 days. Supportive care, including antipyretics and oxygen therapy, was provided to both groups as necessary. Randomization was performed by an independent investigator who did not participate in patient treatment or follow-up.

The primary outcome measure was clinical improvement within 72 hours, assessed through parameters such as reduction in fever, improvement in respiratory rate, and reduction in chest indrawing. Secondary outcomes included duration of hospital stay, incidence of complications (e.g., pleural effusion), rate of treatment failure (e.g., lack of improvement or need for therapy change), and adverse drug reactions.

Data were collected using structured case record forms (CRFs) at baseline, 72 hours, and discharge. Recorded parameters included demographic data, clinical signs, laboratory findings, radiological findings, and treatment response.

Statistical analysis was performed using SPSS version 19.0. Descriptive statistics such as mean, standard deviation, and percentage were calculated. Inferential statistics, including the Chi-square test for categorical data and the t-test for continuous data, were applied. A p-value of <0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Ethics Committee (IEC), and informed consent was secured from the parents or legal guardians of all participating children. Patient confidentiality and data security were maintained throughout the study.

## Results

### Table 1: Demographic Characteristics of the Study Population

The demographic characteristics of the study population showed no significant differences between the IV antibiotics group and the oral antibiotics group. The mean age in the IV antibiotics group was 6.84 ± 2.7 years, while in the oral antibiotics group, it was 6.98 ± 3.1 years (p = 0.72). Gender distribution was also comparable, with 62% males and 38% females in the IV antibiotics group, and 52% males and 48% females in the oral antibiotics group (p = 0.28).In terms of anthropometric parameters, the mean weight was 19.2 ± 4.3 kg in the IV group and 18.3 ± 5.1 kg in the oral group (p = 0.45). Similarly, the mean height was 109.1 ± 11.6 cm in the IV group and 111.0 ± 9.2 cm in the oral group (p = 0.33). The mean BMI was slightly higher in the IV group (16.8 ± 6.2) compared to the oral group (15.0 ± 4.7), but this difference was not statistically significant (p = 0.21). These results indicate that the two groups were well-matched in terms of baseline demographic and physical parameters, ensuring the validity of comparisons made in subsequent analyses.

### Table 2: Clinical Improvement Within 72 Hours

The analysis of clinical improvement parameters revealed significant differences between the two groups. The mean time to clinical improvement was significantly shorter in the IV antibiotics group (70.5 ± 4.8 hours) compared to the oral antibiotics group (73.2 ± 5.1 hours) (p = 0.03). Additionally, the mean time to fever reduction was also significantly lower in the IV antibiotics group (23.8 ± 4.5 hours) than in the oral antibiotics group (26.4 ± 5.2 hours) (p = 0.04).

Furthermore, the mean oxygen saturation levels were higher in the IV antibiotics group (96.5 ± 1.8%) compared to the oral antibiotics group (94.8 ± 2.2%) (p = 0.02). These findings suggest that IV antibiotics facilitated faster clinical improvement, earlier fever resolution, and better oxygenation outcomes in pediatric patients compared to oral antibiotics.

### Table 3: Duration of Hospital Stay

The duration of hospital stay and related parameters indicated statistically significant differences between the two groups. The mean hospital stay was shorter in the IV antibiotics group (6.5 ± 1.2 days) compared to the oral antibiotics group (7.1 ± 1.4 days) (p = 0.04). Additionally, the mean number of days requiring oxygen therapy was significantly lower in the IV antibiotics group (1.8 ± 0.9 days) compared to the oral antibiotics group (2.4 ± 1.1 days) (p = 0.03).

However, the rate of antibiotic switch was higher in the oral antibiotics group (22%) compared to the IV antibiotics group (12%), although this difference was not statistically significant (p = 0.19). These findings indicate that IV antibiotics contributed to shorter hospital stays and reduced dependency on oxygen therapy, enhancing overall recovery efficiency.

### Table 4: Incidence of Complications

The incidence of complications and related events did not show statistically significant differences between the two groups. The proportion of patients experiencing complications was 16% in the IV antibiotics group and 24% in the oral antibiotics group (p = 0.32). Similarly, the need for ICU admission was observed in 8% of patients in the IV group and 14% in the oral group (p = 0.29).

The readmission rate within 30 days was 6% in the IV group and 10% in the oral group (p = 0.47). These results suggest that while there were slightly higher rates of complications, ICU admissions, and readmissions in the oral antibiotics group, these differences were not statistically significant.

### Table 5: Treatment Failure and Adverse Drug Reactions

The analysis of treatment failure and adverse drug reactions revealed no statistically significant differences between the two groups. Treatment failure occurred in 6% of patients in the IV antibiotics group and 10% in the oral antibiotics group (p = 0.47). Adverse drug reactions were reported in 12% of patients in the IV group and 18% in the oral group (p = 0.41).

The need for ICU admission was slightly higher in the oral group (14%) compared to the IV group (8%) (p = 0.29). Additionally, readmission within 30 days was observed in 6% of the IV group and 10% of the oral group (p = 0.47). Lastly, fever rebound occurred in 4% of the IV group and 8% of the oral group (p = 0.39). These results suggest that while there were marginally higher rates of treatment failure, adverse reactions, and fever rebound in the oral group, the differences were not statistically significant.

**Table 1: Demographic Characteristics of the Study Population**

| Parameter | IV Antibiotics (n=50) | Oral Antibiotics (n=50) | p-value |
|---|---|---|---|
| **Mean Age (years)** | 6.84 ± 2.7 | 6.98 ± 3.1 | 0.72 |
| **Gender** | | | |
| **Male** | 31 (62%) | 26 (52%) | 0.28 |
| **Female** | 19 (38%) | 24 (48%) | 0.28 |
| **Mean Weight (kg)** | 19.2 ± 4.3 | 18.3 ± 5.1 | 0.45 |
| **Mean Height (cm)** | 109.1 ± 11.6 | 111.0 ± 9.2 | 0.33 |
| **Mean BMI** | 16.8 ± 6.2 | 15.0 ± 4.7 | 0.21 |

**Table 2: Clinical Improvement Within 72 Hours**

| Parameter | IV Antibiotics (n=50) | Oral Antibiotics (n=50) | p-value |
|---|---|---|---|
| **Mean Time to Improvement (hrs)** | 70.5 ± 4.8 | 73.2 ± 5.1 | 0.03* |
| **Mean Time to Fever Reduction (hrs)** | 23.8 ± 4.5 | 26.4 ± 5.2 | 0.04* |
| **Mean Oxygen Saturation (%)** | 96.5 ± 1.8 | 94.8 ± 2.2 | 0.02* |

**Table 3: Duration of Hospital Stay**

| Parameter | IV Antibiotics (n=50) | Oral Antibiotics (n=50) | p-value |
|---|---|---|---|
| **Mean Hospital Stay (days)** | 6.5 ± 1.2 | 7.1 ± 1.4 | 0.04* |
| **Mean Days on Oxygen** | 1.8 ± 0.9 | 2.4 ± 1.1 | 0.03* |
| **Antibiotic Switch (%)** | 6 (12%) | 11 (22%) | 0.19 |

**Table 4: Incidence of Complications**

| Complications | IV Antibiotics (n=50) | Oral Antibiotics (n=50) | p-value |
|---|---|---|---|
| **Yes** | 8 (16%) | 12 (24%) | 0.32 |
| **No** | 42 (84%) | 38 (76%) | 0.32 |
| **Need for ICU (%)** | 4 (8%) | 7 (14%) | 0.29 |
| **Readmission within 30 days (%)** | 3 (6%) | 5 (10%) | 0.47 |

**Table 5: Treatment Failure and Adverse Drug Reactions**

| Parameter | IV Antibiotics (n=50) | Oral Antibiotics (n=50) | p-value |
|---|---|---|---|
| **Treatment Failure** | 3 (6%) | 5 (10%) | 0.47 |
| **Adverse Reactions** | 6 (12%) | 9 (18%) | 0.41 |
| **Need for ICU (%)** | 4 (8%) | 7 (14%) | 0.29 |
| **Readmission within 30 days (%)** | 3 (6%) | 5 (10%) | 0.47 |
| **Fever Rebound (%)** | 2 (4%) | 4 (8%) | 0.39 |

## Discussion

The demographic characteristics of the study population demonstrated no significant differences between the IV and oral antibiotics groups, confirming a well-matched cohort for comparison. Similar findings have been reported in studies comparing IV and oral antibiotics in pediatric pneumonia. For instance, Madhi et al. (2011) emphasized the importance of baseline demographic comparability in pneumonia trials to ensure reliable outcomes.[6] Additionally, Rudan et al. (2008) highlighted the role of anthropometric parameters, such as weight and BMI, in influencing disease outcomes, although our results indicated no significant disparities in these measures.[7]The study revealed that IV antibiotics were associated with faster clinical improvement, earlier fever resolution, and better oxygenation compared to oral antibiotics. A similar trend was observed in a study by Addo-Yobo et al. (2012), which demonstrated that children receiving IV antibiotics showed quicker resolution of clinical symptoms.[8] Moreover, Lodha et al. (2013) reported that early fever reduction is a reliable indicator of effective antibiotic therapy, aligning with our findings of a shorter mean time to fever reduction in the IV group.[9]Oxygen saturation levels were also significantly higher in the IV antibiotics group. This outcome is consistent with findings by Hazir et al. (2011), who noted improved oxygenation in children treated with IV antibiotics, particularly in cases of severe pneumonia.[10]The IV antibiotics group experienced a shorter hospital stay and fewer days on oxygen therapy compared to the oral antibiotics group. A randomized trial by Campbell et al. (2012) similarly demonstrated that IV antibiotics significantly reduced hospital stay duration in pediatric pneumonia.[11] Furthermore, these findings are corroborated by Maimaiti et al. (2014), who observed faster recovery and reduced oxygen dependency in children treated with IV

antibiotics.[12]The antibiotic switch rate was higher in the oral antibiotics group, although not statistically significant. This aligns with research by Sazawal et al. (2008), which noted a higher likelihood of therapy modification in oral antibiotic regimens due to slower clinical response.[13]The incidence of complications, including ICU admissions and readmissions, showed no significant differences between the two groups. These results are consistent with findings by Falade et al. (2014), who reported comparable complication rates in children treated with IV versus oral antibiotics for pneumonia.[14] Similarly, Le Saux et al. (2009) found that while oral antibiotics were slightly more associated with ICU admissions, the differences were not statistically significant, as observed in our study.[15]Treatment failure and adverse reactions were marginally higher in the oral antibiotics group but without statistical significance. This is consistent with a study by Zar et al. (2007), which reported slightly increased failure rates in oral antibiotic therapy, particularly in younger children or those with severe symptoms.[16]Adverse reactions were also more common in the oral antibiotics group, likely due to gastrointestinal side effects, a pattern previously documented by Ayieko et al. (2012).[17] Similarly, Lodha et al. (2013) observed that adverse reactions were more frequent in oral regimens, particularly in the form of antibiotic-associated diarrhea.[18]

## Conclusion

This comparative study demonstrated that intravenous (IV) antibiotics offer faster clinical improvement, earlier fever resolution, better oxygenation, and shorter hospital stays compared to oral antibiotics in the treatment of pediatric pneumonia. However, both treatment modalities showed similar rates of complications, treatment failure, and adverse drug reactions. While IV antibiotics may be preferred in severe cases requiring rapid intervention, oral antibiotics remain a viable and cost-effective option for mild to moderate pneumonia. These findings highlight the importance of individualized treatment approaches based on clinical severity, resource availability, and patient tolerance to optimize outcomes in pediatric pneumonia management.

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