

Role of Zinc as Adjuvant Therapy in Acute Pneumonia in Clinical Recovery of Age 2 Months to 5 Years**Pawan Kumar Meena¹, Anu Priya², Ashok Kumar³, Anushri Chourasia⁴, Kunal Kumar⁵, Atul Anand⁶, Jishan Alam Siddiqui⁷**^{1,2,4,5,6,7}Junior Resident (Academic), Department of Pediatrics, Darbhanga Medical College & Hospital, Laheriasarai, Darbhanga, Bihar- 846003, India³Professor & H.O.D, Department of Pediatrics, Darbhanga Medical College & Hospital, Laheriasarai, Darbhanga, Bihar- 846 003, India

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Abstract:**Background:** Acute pneumonia remains a leading cause of mortality and morbidity in children under five, particularly in developing nations. Zinc, a key micronutrient, plays a critical role in immune function, and its deficiency is associated with increased susceptibility to infections.**Aim:** To evaluate the effectiveness of zinc as an adjuvant therapy in improving clinical recovery outcomes in children aged 2 months to 5 years hospitalized with acute pneumonia.**Methods:** A prospective, randomized, controlled trial was conducted at the Department of Pediatrics, DMCH, and Laheriasarai. A total of 160 children diagnosed with acute pneumonia were randomly assigned to either a zinc-supplemented group (Group A, n=80) or a control group receiving standard care only (Group B, n=80). Outcomes including recovery time, duration of hospitalization, and need for oxygen support were compared. Zinc was administered as 10 mg/day for infants <12 months and 20 mg/day for those ≥12 months, for 7–14 days.**Results:** Patients in the zinc group showed a trend toward faster clinical recovery (mean 3.78 days vs. 4.22 days in control), though not statistically significant (p=0.22). Hospital stay was slightly shorter in the zinc group (mean 5.71 vs. 6.23 days; p=0.22). Adverse effects such as rash and diarrhea were significantly more frequent in the zinc group (p<0.001). No significant differences were found in baseline characteristics, antibiotic use, or final recovery rates (zinc: 95%; control: 97.5%).**Conclusion:** Zinc supplementation may offer a modest benefit in accelerating recovery in children with acute pneumonia, though it was not statistically significant in this study. Given its safety profile and immunological benefits, zinc could be considered a supportive adjunct therapy, especially in populations at risk for micronutrient deficiency.**Keywords:** Zinc, Pneumonia, Children, Adjuvant therapy, Micronutrient, Recovery.

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Introduction

Acute respiratory infections (ARIs), with pneumonia being the most severe manifestation, remain a leading cause of morbidity and mortality in children under five years of age globally. Despite advances in immunization and antibiotic therapies, pneumonia continues to account for approximately 15% of all deaths in this age group, with the World Health Organization (WHO) estimating nearly 700,000 annual fatalities, primarily in low- and middle-income countries (LMICs) such as those in South Asia and sub-Saharan Africa. In India, pneumonia is one of the foremost causes of under-five mortality, second only to neonatal conditions. [1,2] The etiology of pneumonia is multifactorial, involving bacterial, viral, and atypical pathogens. Contributing risk factors include malnutrition, lack

of exclusive breastfeeding, poor sanitation, indoor air pollution, and limited access to timely healthcare. Among these, nutritional deficiencies—particularly of essential micronutrients such as zinc—play a critical role in increasing susceptibility to infections and in delaying recovery. [3] Zinc is the second most abundant trace element in the human body after iron and plays a pivotal role in numerous physiological processes. It is crucial for cellular growth, gene expression, wound healing, and maintenance of epithelial barrier integrity. More importantly, zinc modulates both innate and adaptive immunity by influencing the activity of neutrophils, natural killer (NK) cells, macrophages, and T-lymphocytes. Zinc deficiency has been associated with impaired immune responses, prolonged

illness, and an increased risk of infection-related complications. [4] In the context of pneumonia, zinc contributes to mucosal barrier function in the respiratory epithelium, supports ciliary activity, regulates inflammatory cytokine production, and provides antioxidant defense—factors vital in both preventing infection and promoting recovery. Globally, nearly one-third of the population is at risk of zinc deficiency, with preschool-aged children in resource-constrained settings being most affected due to poor dietary intake, low bioavailability of zinc from vegetarian diets, and increased losses during illness. [5,6,7,8]

Emerging evidence suggests that zinc supplementation, either prophylactically or therapeutically, may reduce the incidence, severity, and duration of acute lower respiratory infections (ALRIs). Although several randomized controlled trials and meta-analyses have examined the efficacy of zinc as an adjunct to standard pneumonia treatment, findings have been inconsistent due to heterogeneity in study designs, baseline zinc status, and dosing regimens. [9-12]

Given the high burden of paediatric pneumonia and widespread zinc deficiency in India, exploring zinc supplementation as a low-cost, accessible adjunct therapy could offer significant public health benefits. This study aims to evaluate the clinical impact of zinc supplementation on recovery outcomes among children aged 2 months to 5 years admitted with acute pneumonia. By assessing key parameters such as fever resolution, respiratory rate normalization, oxygen saturation, and hospital stay duration, the study seeks to determine whether zinc can enhance clinical recovery when administered alongside conventional treatment.

Materials and Methodology

Research Design and Setting: This current prospective, randomized, controlled trial was performed at the Department of Pediatrics at Darbhanga Medical College and Hospital (DMCH), Laheriasarai. The study compared outcomes between two groups: one receiving standard treatment along with zinc supplementation and the other receiving standard treatment alone.

The study was performed over a specific period, adhering to standardized protocols for both data collection and patient care. Permission to initiate the current study was approved through the Institution Ethical board members. A written informed assent was secured from parental or legal authority prior to enrolling the subjects.

Study Population: Children between 2 months to 5 years having clinical indications of acute pneumonia according to IMNCI criteria were considered eligible for the study.

Inclusive parameter

- All children of 2 months to 5 years fulfilling IMNCI guideline for severe pneumonia.

Exclusive parameter

All pneumonia other than community acquired pneumonia was excluded such as:

- Congenital lung and heart deformities.
- Delayed development.
- Suggestive of severe acute malnutrition.
- Tuberculosis.
- Previous record of consumption of zinc intake over the last 3-month and having diarrhoea.

Sample Size estimation: The cohort size for the current research was calculated as per the data from previously published research evaluating the impact of zinc intake in paediatric patients suffering from acute pneumonia. The calculation was guided by the anticipated difference in the mean length of hospital stay or time to symptom resolution between the intervention and control groups, designated as the primary outcome measure.

To detect a clinically meaningful reduction in recovery time (e.g., 1-day difference in hospital stay), with a power of 80% ($\beta = 0.20$) as well as a confidence level of 95% ($\alpha = 0.05$), the population size was estimated by the below mentioned formula for comparing two means:

$$n = \frac{2\sigma^2(Z_{\alpha/2} + Z_{\beta})^2}{(\mu_1 - \mu_2)^2}$$

Where:

n = sample size per group

σ = standard deviation (assumed from previous literature to be ~2 days)

$\mu_1 - \mu_2$ = expected difference in means (set at 1 day)

$Z_{\alpha/2} = 1.96$ (for 95% confidence level)

$Z_{\beta} = 0.84$ (for 80% power)

$$n = \frac{2 \times 2^2 \times (1.96 + 0.84)^2}{1^2} = \frac{8 \times 7.84}{1} = 62.72$$

Rounding up, the required sample size per group was estimated to be 63 children. Considering potential dropouts or losses to follow-up, an additional buffer was added.

Thus, the ultimate sample size was fixed at 80 children per group, total 160 participants in the present investigation.

The cohort size was calculated on the basis of previous studies and estimated effect size. One hundred sixty children were selected for the study and

allocated in a 1:1 ratio to two groups through randomization through a computer-generated sequence.

Grouping

- **Group A (Intervention Group):** Received standard treatment for pneumonia as per hospital protocol plus oral zinc supplementation (10 mg/day for children under 12 months and 20 mg/day for children above 12 months) for 7–14 days.
- **Group B (Control Group):** Received standard treatment without zinc supplementation.

Intervention: Zinc sulfate was administered in syrup form, once daily, according to age-appropriate dosing guidelines. Both groups were monitored for clinical improvement, adverse reactions, and complications.

Outcome Measures

Primary Outcomes:

- Time to resolution of fever.
- Time to cessation of tachypnea.
- Period of hospitalization.

Secondary Outcomes:

- Recurrence of pneumonia within 3 months.
- Requirement for intensive care or oxygen support.
- Any adverse effects of zinc supplementation.

Data Collection

A structured proforma was used to collect baseline demographic data, clinical features, laboratory findings, and treatment details. Follow-up was con-

ducted until discharge and again after 3 months to check for recurrence.

Statistical Evaluation: Data were compiled and analyzed via software SPSS ver.25. Descriptive statistics were expressed as average \pm standard deviation (SD) for quantitative data and frequencies/% for qualitative data. Comparisons between categories were performed via appropriate statistical tool like Student's t-test and Chi-square test depending on the type of data to be evaluated. A p-value <0.05 was set to be statistically significant.

Results

This present investigation was performed over a duration of eighteen months and included a total of 160 participants. The research was performed in the Outpatient Department of Paediatrics at DMCH, Laheriasarai. Paediatric cases diagnosed with acute pneumonia were enrolled in the study according to predefined inclusion criteria.

Distribution of participants by age: The age-wise distribution of the 160 enrolled paediatric patients with acute pneumonia is presented in both Table 4.1 and Figure 4.1. The greater number of cases was observed in the 37–48 months of age group, accounting for 22.50% (n=36) of the total sample.

This was followed by the 25–36 months of group with 21.25% (n=34), the 13–24 months of group with 20.00% (n=32), and both the 1–12 months and 49–60 months of age groups, each comprising 18.13% (n=29 and n=29 respectively). The mean participant's age was 30.53 ± 16.41 months.

Table 1: Age-wise distribution of enrolled patients in years

Age Group (Months)	Frequency (%) (n=160)
1-12	29 (18.13)
13-24	32 (20.00)
25-36	34 (21.25)
37-48	36 (22.50)
49-60	29 (18.12)
Mean \pm SD	30.53 \pm 16.41

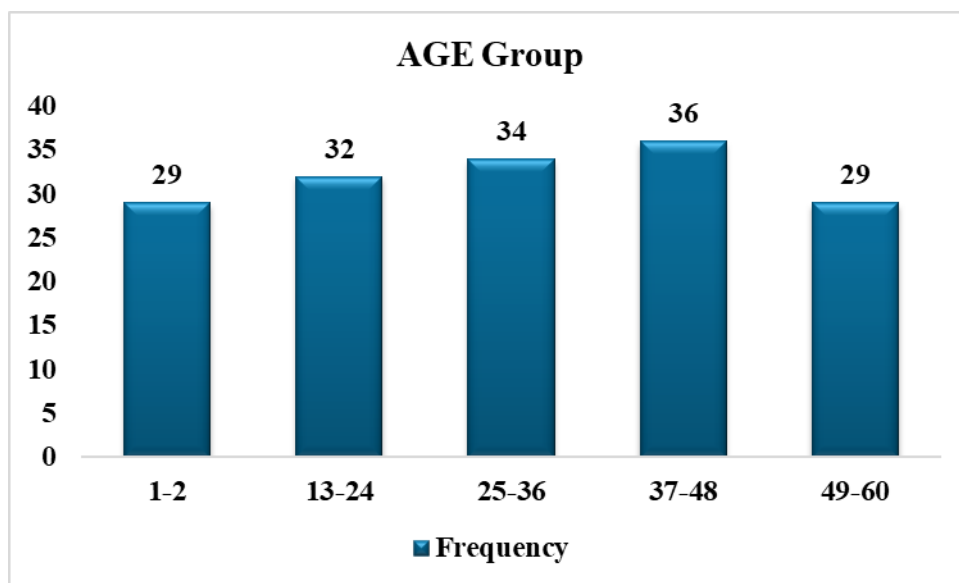


Figure 1: Demographic distribution by age

Distribution of patients by gender: Table 4.2 and Figure 4.2 presents the sex-wise allocation of the 160 enrolled patients with acute pneumonia. Of the total participants, 82 (51.25%) were female, while 78 (48.75%) were male. This indicates a slight predominance of female patients in the study population.

Table 2: Gender-wise distribution of patients with acute pneumonia

Gender	Frequency (%) (n=160)
Male	78 (48.75)
Female	82 (51.25)

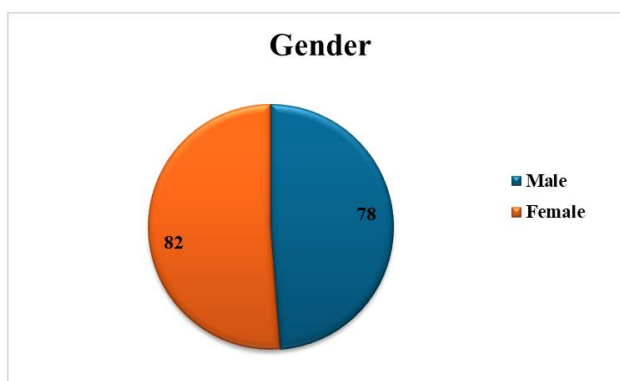


Figure 2: Patient Demographics: Gender Distribution

Distribution of acute pneumonia patients by weight: The weight-wise distribution of acute pneumonia patients is shown in Table 4.3 and Figure 4.3. The majority of the patients (48.13%, n=77) had a body weight between 11–15 kg, fol-

lowed by 26.25% (n=42) in the 16–20 kg range and 25.00% (n=40) in the 6–10 kg range. Only one patient (0.63%) had a weight between 1–5 kg. The mean body weight of the study population was 13.05 kg with a standard deviation of 3.68 kg.

Table 3: Weight-wise distribution of acute pneumonia patients

Weight (Kg)	Frequency (%), (n=160)
1-5	1 (00.63)
6-10	40 (25.00)
11-15	77 (48.13)
16-20	42 (26.25)
Mean ± SD	13.05 ± 3.68

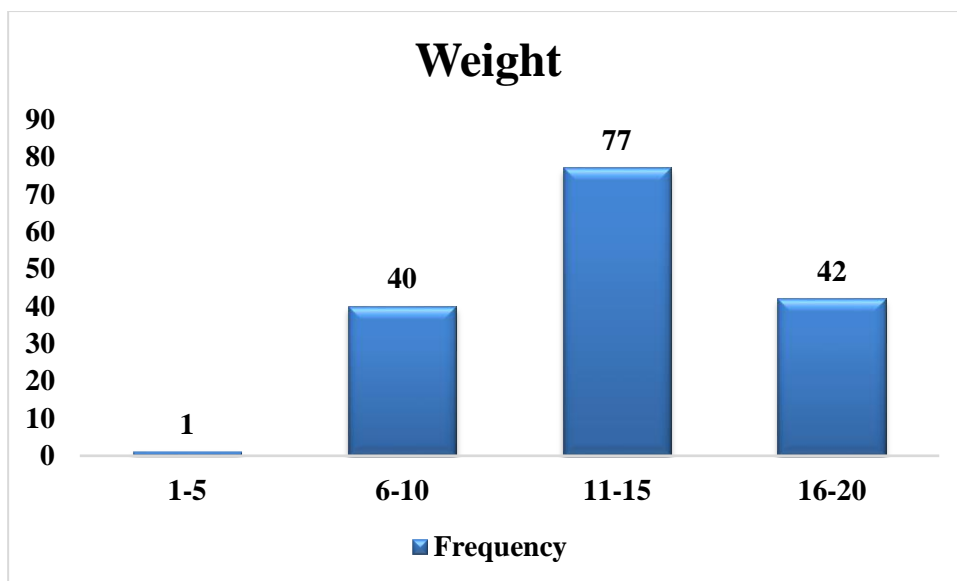


Figure 3: Frequency of patients by weight categories

Different clinical parameters with acute pneumonia in patients: Table 4 and Figure 4 presents the allocation of two clinical parameters—chest in-drawing and feeding difficulty—among the 160 patients with acute pneumonia. Chest in-drawing was observed in 76 patients (47.50%), while 84

patients (52.50%) did not exhibit this sign. Feeding difficulty was present in 83 patients (51.88%) and absent in 77 patients (48.13%). The p-values for these parameters were not provided, indicating that statistical significance could not be determined from the available data.

Table 4: Clinical indicators associated with acute pneumonia

Parameters (n=160)	Frequency (%)
Chest In-drawing	76 (25.00)
Feeding Difficulty	83 (48.13)

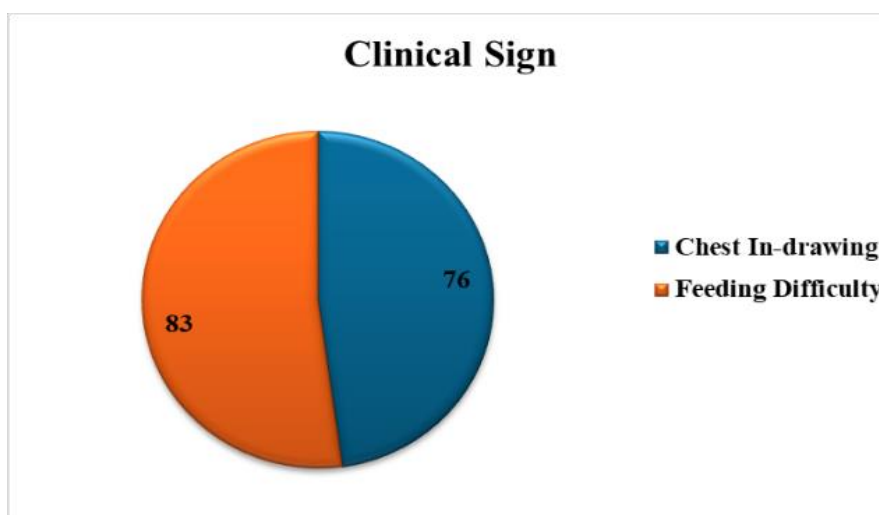


Figure 4: Assessment of clinical characteristics in acute pneumonia

Body Temperature profiles of pneumonia patients: Table 4.5 and Figure 4.5 illustrates the allocation of acute pneumonia patients based on body temperature. The highest proportion of patients (36.25%, n=58) presented with a temperature between 38–38.9°C, followed closely by 34.38%

(n=55) with a temperature in the range of 39–39.9°C. A total of 43 patients (26.88%) had temperatures between 37–37.9°C, while only 4 patients (2.50%) exhibited a high fever in the range of 40–40.9°C. The mean body temperature of the study population was 38.55°C with a standard deviation.

Table 5: Body temperature-wise distribution of acute pneumonia patients

Temperature (°C)	Frequency (%) (n=160)
37-37.9	43 (26.88)
38-38.9	58 (36.25)
39-39.9	55 (34.38)
40-40.9	4 (02.50)
Mean ± SD	38.55 ± 0.84

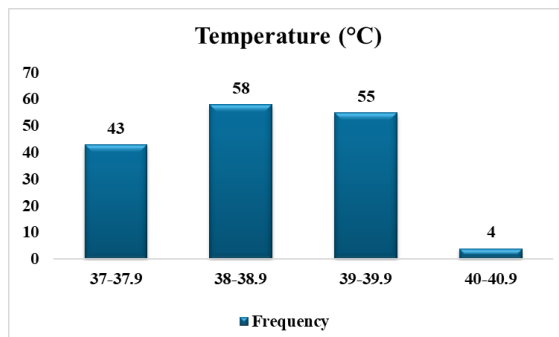


Figure 5: Frequency of patients by weight categories

Oxygen saturation profiles among pneumonia patients: Table 4.6 and Figure 4.6 presents the allocation of acute pneumonia patients based on oxygen saturation levels. The majority of patients (46.25%, n=74) had oxygen saturation levels between 91–96%, followed by 32.50% (n=52) in the

97–100% range. A total of 34 patients (21.25%) had lower oxygen saturation levels between 85–90%. The mean oxygen saturation among the study population was 94.13% with a standard deviation of 3.71%.

Table 6: Oxygen saturation -wise distribution of acute pneumonia patients

Oxygen Saturation (%)	Frequency (%) (n=160)
85-90	34 (21.25)
91-96	74 (46.25)
97-100	52 (32.50)
Mean ± SD	94.13 ± 3.71

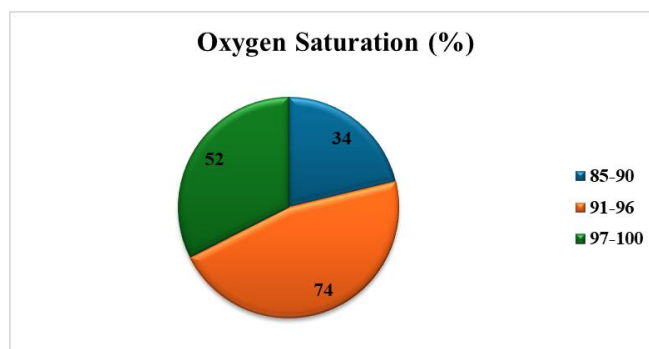


Figure 6: Oxygen saturation classification in acute pneumonia cases

Distribution of acute pneumonia patients by cough duration: Table 7 and Figure 7 displays the allocation of acute pneumonia patients based on the duration of cough. A slight majority of patients

(53.13%, n=85) experienced a cough lasting 1–5 days, while 46.88% (n=75) reported a duration of 6–10 days. The mean duration of cough among the study participants was 5.42 ± 2.78 days.

Table 7: Duration of cough distribution of acute pneumonia patients

Duration of cough (Days)	Frequency (%) (n=160)
1-5	85 (53.13)
6-10	75 (46.88)
Mean ± SD	5.42 ± 2.78

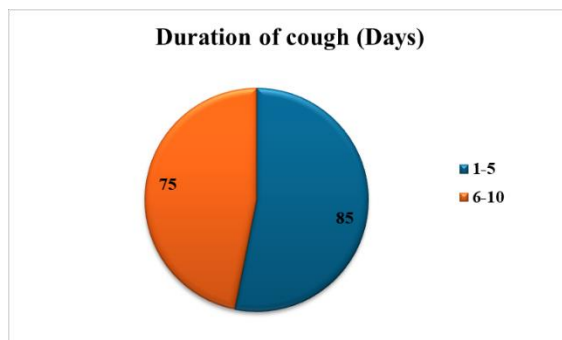


Figure 7: Classification of patients based on duration of cough

Distribution of zinc supplement use in pneumonia cases: Table 4.8 and Figure 4.8 presents the allocation of acute pneumonia patients based on zinc supplementation. Out of the total 160 patients,

80 (50%) received zinc supplements, while the remaining 80 (50%) did not. This indicates an equal distribution of zinc supplementation among the study population.

Table 8: Zinc supplement distribution of acute pneumonia patients

Zinc supplement	Frequency (%) (n=160)
Yes	80 (50)
No	80 (50)

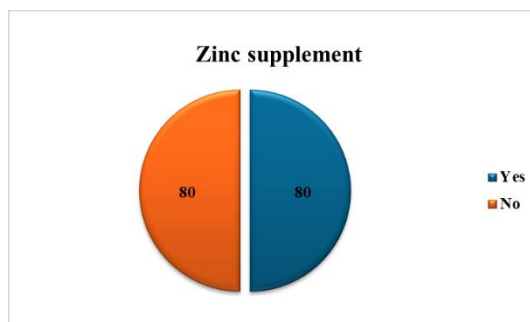


Figure 8: Zinc supplement intake among study participants

Zinc supplement treatment duration in pneumonia cases: Table 4.9 and Figure 4.9 show the division of acute pneumonia cases on the basis of duration of zinc supplementation among those who

received it (n=80). A majority of the patients (57.50%, n=46) were administered zinc supplements for a duration of 5–10 days, while 42.50% (n=34) received supplementation for 11–16 days.

Table 9: Duration of Zinc supplement distribution of acute pneumonia patients

Duration of Zinc supplement given (Days)	Frequency (%) (n=80)
5-10	46 (57.50)
11-16	34 (42.50)

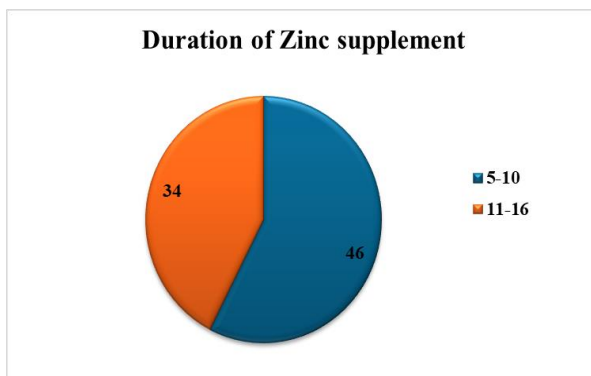


Figure 9: Zinc supplementation period distribution

Antibiotic usage among acute pneumonia patients: Table 4.10 and Figure 4.10 presents the allocation of antibiotics administered to acute pneumonia patients among those who received treatment (n=80). Cefixime emerged as the anti-

biotic most frequently prescribed, given to 27 patients (33.75%), followed by Amoxicillin in 17 patients (21.25%) and Azithromycin in 14 patients (17.50%). Notably, 22 patients (27.50%) did not receive any antibiotic therapy.

Table 10: Antibiotic distribution of acute pneumonia patients

Antibiotic given	Frequency (%) (n=80)
Amoxicillin	17 (21.25)
Azithromycin	14 (17.50)
Cefixime	27 (33.75)
None	22 (27.50)

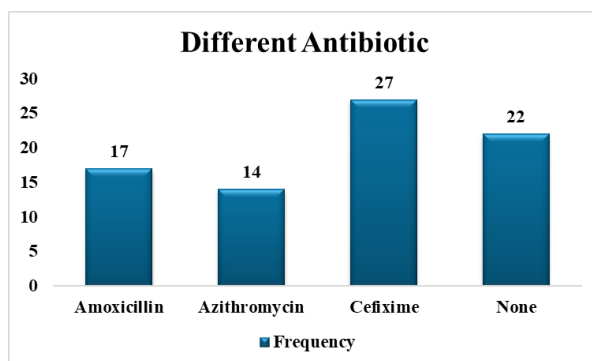


Figure 10: Distribution of antibiotic treatments in pneumonia cases

Adverse effects observed in acute pneumonia patients: Table 11 summarizes the adverse effects observed among the 160 acute pneumonia patients. Rash was the most frequently reported adverse effect, occurring in 27 patients (16.88%), followed by

diarrhoea in 23 patients (14.37%) and vomiting in 20 patients (12.50%). More than half of the patients (56.25%, n=90) did not experience any adverse effects.

Table 11: Adverse effects of acute pneumonia patients

Adverse effects	Frequency (%) (n=160)
Diarrhoea	23 (14.37)
Vomiting	20 (12.50)
Rash	27 (16.88)
None	90 (56.25)

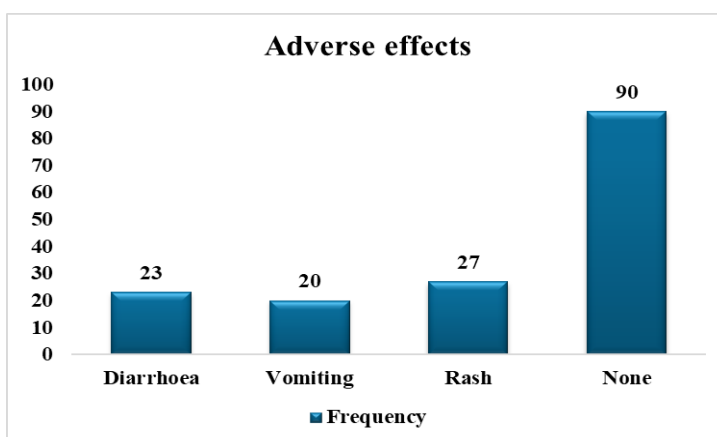


Figure 11: Incidence of side effects among pneumonia patients

Duration of hospitalization in acute pneumonia patients: Table 12 the duration of hospital stay among the 160 acute pneumonia patients. A total of 88 patients (55%) had a hospital stay of 6–10 days, while 72 patients (45%) stayed for 1–5 days. The mean duration of hospitalization was 5.98 ± 2.71 days.

Table 12: Hospital stay of acute pneumonia patients

Hospital stay (Days)	Frequency (%) (n=160)
1-5	72 (45)
6-10	88 (55)
Mean ± SD	5.98 ± 2.71



Figure 12: Length of hospital stay among pneumonia cases

Recovery time in acute pneumonia patients: Table 13 illustrates the clinical recovery time of acute pneumonia patients. The majority of patients (75.63%, n=121) recovered within 2–5 days, while

22.50% (n=36) took 6–9 days to recover. A small proportion of patients (1.88%, n=3) experienced recovery times exceeding 10 days. The mean interval of clinical improvement was 4.01 ± 2.27 days.

Table 13: Clinical recovery of acute pneumonia patients

Clinical recovery (Days)	Frequency (%) (n=160)
2-5	121 (75.63)
6-9	36 (22.50)
>10	3 (01.88)
Mean ± SD	4.01 ± 2.27

Recovery status of patients with acute pneumonia: Table 14 and Figure 14 presents the clinical recovery outcomes of the 160 acute pneumonia patients. A vast majority of patients, 154 (96.25%), achieved full recovery, while 6 patients (3.75%) did not recover within the study period.

Table 14: Clinical recovery outcome of acute pneumonia patients

Clinical Outcome	Frequency (%) (n=160)
Recovered	154 (96.25)
None	6 (03.75)

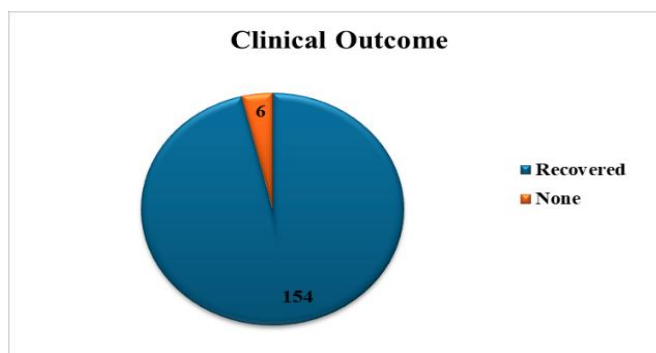


Figure 14: Outcome assessment of clinical recovery in pneumonia

Assessing the role of zinc administration in paediatric acute pneumonia: Table 15 presents a comparative analysis of various clinical and physiological parameters among acute pneumonia participants allocated to receive zinc supplementation (n = 80) were correlated with those who were not

given supplementation (n = 80). There were statistically insignificant variation between the two groups in the context of weight (p=0.12), respiratory rate (p=0.51), oxygen saturation (p=0.30), temperature (p=0.74), cough duration (p=0.32), hospital stay duration (p=0.22), or days to recovery

(p=0.22). However, a highly substantial difference (p ≤ 0.001) was seen in the duration of zinc admin-

istration, which is expected as only one group received the supplement.

Table 15: Comparison of risk factors and clinical outcomes between acute pneumonia patients with and without zinc supplementation

Risk factors	Zinc supplement		p-value
	Yes (n=80)	No (n=80)	
Weight	12.60± 3.90	13.49 ±3.40	0.12
Respiratory rate	51.16 ± 11.53	49.92 ± 12.49	0.51
Oxygen Saturation (%)	94.42 ± 3.75	93.82 ± 3.67	0.30
Temperature (°C)	38.52± 0.84	38.56 ± 0.83	0.74
Cough Duration (Days)	5.63 ± 2.86	5.20 ± 2.67	0.32
Duration of Zinc (Days)	9.60 ± 2.79	0.48 ± 2.21	≤0.001*
Hospital Stays	5.712 ± 2.64	6.23 ± 2.75	0.22
Days of recovery	3.78 ± 2.04	4.22 ± 2.46	0.22

Influence of zinc administration on risk factors and clinical consequences among acute pneumonia subjects

The distribution of key risk factors among acute pneumonia patients receiving zinc supplementation (n=80) compared to those not receiving zinc (n=80) is summarized in Table 4.16. Gender distribution was identical in both groups, with 41 females and 39 males each (p = 1.00). The prevalence of chest in-drawing was similar, occurring in 39 patients in

the zinc group and 37 in the non-zinc group (p = 0.75). Feeding difficulty was reported in 42 patients receiving zinc and 41 patients not receiving zinc (p = 0.87).

Regarding clinical outcomes, 76 children in the zinc group and 78 in the non-zinc category recovered, with no statistically substantial difference (p = 0.40). These findings indicate no significant differences in baseline risk factors or recovery outcomes between the two groups.

Table 16: Comparison of risk factors and clinical outcomes between acute pneumonia patients with and without zinc supplementation

Risk factors	Zinc supplement		p-value
	Yes (n=80)	No (n=80)	
Gender			1.00
Female	41	41	
Male	39	39	
Chest In-drawing			0.75
Yes	39	37	
No	41	43	
Feeding Difficulty			0.87
Yes	42	41	
No	38	39	
Outcome			0.40
Recovered	76	78	
Not Recovered	4	2	

Antibiotic use and adverse effects: Evaluating the function of zinc supplementation in acute pneumonia management

Table 17 compares the distribution of antibiotics and adverse effects among acute pneumonia patients who received zinc administration (n=80) and those who did not receive (n=80). Insignificant variation (p = 0.61) was noted in antibiotic usage between the two groups. Amoxicillin was given equally in both groups (n=17), azithromycin was administered to 14 patients in zinc group versus 20 subjects in the non-zinc group, cefixime was slight-

ly more used in zinc group (n=27) than in the non-zinc group (n=21), as well as 22 patients in each group did not receive antibiotics. Conversely, the incidence of adverse effects differed significantly between groups, with a p-value ≤ 0.001.

Patients in the zinc group experienced a higher frequency of diarrhoea (n=20), rash (n=27), and vomiting (n=19), whereas the non-zinc group had minimal occurrences: diarrhoea (n=3), rash (n=0), and vomiting (n=1). Notably, 76 patients in the non-zinc group reported no adverse effects compared to only 14 in the zinc group.

Table 17: Comparison of antibiotic use and adverse effects between acute pneumonia patients with and without zinc supplementation

Risk factors	Zinc supplement		p-value
	Yes (n=80)	No (n=80)	
Antibiotic Given			0.61
Amoxicillin	17	17	
Azithromycin	14	20	
Cefixime	27	21	
None	22	22	
Adverse Effect			≤0.001*
Diarhoea	20	3	
Rash	27	0	
Vomiting	19	1	
None	14	76	

Discussion

Pneumonia is a major contributing factor of death among children under five, particularly in LMICs, despite the accessibility of vaccines, immune competence, and delays in recovery. It is accountable for almost 15% of mortality within this age group globally, with the highest incidence concentrated in South Asia and sub-Saharan Africa.

In India, pneumonia ranks second among causes of under-five mortality. The etiology of pneumonia is complex, involving bacterial, viral, and atypical pathogens, with risk exacerbated by malnutrition, poor sanitation, air pollution, and limited healthcare access. Among nutritional factors, zinc deficiency has emerged as a key modifiable risk that compromises

Zinc is a vital micronutrient involved in maintaining epithelial barriers, modulating immune responses, and supporting cellular repair processes. Its deficient condition is correlated with impaired immunity, higher susceptibility to infections, and prolonged illness. Globally, zinc deficiency impacts nearly one-third of the population, with young children in developing regions being most at risk due to inadequate intake and increased loss during infections. Evidence suggests that zinc administration may lower the incidence, acuteness, and duration of lower RTIs. However, results from clinical trials remain variable, possibly due to differences in study populations, zinc status at baseline, dosing regimens, and diagnostic criteria. Despite this, zinc is widely endorsed for treating paediatric diarrhoea, and its utility in pneumonia is under active investigation.

This study targets children age range from 2 months to 5 years hospitalized with acute pneumonia—a group highly susceptible to both infections and micronutrient deficiencies. The aim is to assess the adjunctive role of zinc in improving clinical recovery, measured through key outcomes such as fever resolution, respiratory rate normalization, oxygen saturation, and length of hospitalization.

Age-based participant distribution

The age-wise distribution of enrolled patients in this study shows a fairly even spread across the different pediatric age groups, ranging from 1 to 60 months, with the highest proportion observed in the 37–48 months group (22.50%), followed closely by the 25–36 months group (21.25%). These findings suggest that toddlers and preschool-age children may be more susceptible or more frequently enrolled in healthcare services for the condition under investigation.

The mean age of participants was 30.53 ± 16.41 months, indicating a broad representation of early childhood. Previous studies have similarly reported that certain paediatric conditions are more prevalent or more likely to be diagnosed during the second to fourth years, a critical phase of growth and immune system progression. [13]

These findings highlight the need for age-specific health promotion strategies and early intervention programs, especially targeting the 25–48 months age range, which appears most engaged in clinical care.

Gender-based distribution of patients

In our cohort of 160 children hospitalized with acute pneumonia, the gender distribution was nearly equal, with females (51.25%) slightly outnumbering males (48.75%). This contrasts with many previous studies reporting a modest male predominance in paediatric pneumonia admissions. For instance, Nair et al. (2013) found that boys accounted for approximately 55% of admissions for severe lower respiratory infections globally, suggesting anatomical or immunological differences as potential drivers of susceptibility. [14] Our nearly balanced gender distribution underscores the importance of continuing gender-neutral prevention and treatment strategies in pediatric pneumonia care.

Body Weight Distribution among Acute Pneumonia Cases

The weight-wise distribution of acute pneumonia patients reveals that the majority fall within the 11–15 kg range (48.13%), followed by the 16–20 kg group (26.25%), and 6–10 kg group (25%). Only one patient (0.63%) belonged to the lowest weight category (1–5 kg), which is likely representative of very young infants.

The mean weight of 13.05 ± 3.68 kg aligns with typical weight-for-age estimates in children aged approximately 1 to 4 years, which is consistent with the age distribution presented earlier in Table 1. [15]

This data also highlights a key point: while pneumonia affects children across various weight categories, targeted attention should still be given to underweight or malnourished children, who remain at higher clinical risk. [16]

Analysis of Clinical Signs among Patients with Acute Pneumonia

Table 4 highlights two significant clinical indicators of acute pneumonia in children: chest indrawing (25.00%) and feeding difficulty (48.13%). These findings reflect core signs commonly used to identify pneumonia severity in pediatric patients, especially in low-resource settings.

Feeding difficulty, observed in nearly half of the patients (48.13%), is a well-recognized early symptom of respiratory distress in infants and young children. [17] It often results from a combination of tachypnea, fatigue, and hypoxia, which can compromise an infant's ability to suck, swallow, or breathe effectively during feeding. [18]

Clinical temperature distribution in pneumonia cases

Table 5 outlines the distribution of body temperature among children diagnosed with acute pneumonia. The majority of patients presented with moderate to high-grade fever: 36.25% had temperatures between $38-38.9^{\circ}\text{C}$, followed closely by 34.38% in the $39-39.9^{\circ}\text{C}$ range. The mean temperature was $38.55 \pm 0.84^{\circ}\text{C}$, indicating that most patients were febrile upon presentation.

Fever is a hallmark symptom of pneumonia and reflects the host's defense response to infection, typically affected by viral or bacterial infectious agents. The relatively high proportion of children with temperatures above 38°C is consistent with pneumonia's systemic inflammatory profile, particularly in cases caused by *Streptococcus pneumoniae* or respiratory syncytial virus (RSV). [19]

Frequency distribution by oxygen saturation

Table 6 provides valuable insight into the oxygen saturation levels among children diagnosed with acute pneumonia. A significant portion (46.25%) had oxygen saturation between 91–96%, while 21.25% had readings in the concerning range of

85–90%. The remaining 32.50% maintained normal oxygen saturation (97–100%). The mean SpO_2 was $94.13 \pm 3.71\%$, suggesting that while most children were not critically hypoxic, a sizable minority were at clinical risk.

Oxygen saturation is a critical parameter in assessing pneumonia severity in paediatric patients. The World Health Organization (WHO, 2014) classifies $\text{SpO}_2 < 90\%$ as indicative of severe disease requiring urgent oxygen therapy. [20] The findings support the recommendation that pulse oximetry should be a routine assessment tool in paediatric pneumonia cases. This helps in triaging and in deciding whether supplemental oxygen or hospitalization is necessary. [21]

Analysis of cough duration in pneumonia patients

Table 4.7 illustrates the distribution of cough duration among children diagnosed with acute pneumonia. Over half of the patients (53.13%) reported cough lasting between 1 to 5 days, while the remaining 46.88% experienced symptoms for 6 to 10 days. The average duration was approximately 5.42 ± 2.78 days, indicating that most children sought medical attention within the first week of symptom onset.

Cough is one of the most common presenting symptoms of pneumonia and is often the earliest clinical manifestation of respiratory tract infections. [22] In acute pneumonia, cough typically begins within a few days of infection and persists as the lungs respond to inflammation and attempts to clear secretions. [23] The findings here suggest that parents or caregivers were responsive to early symptoms, potentially reducing the risk of complications from delayed treatment.

Frequency of Zinc Supplementation in Pneumonia Patients

The equal distribution of zinc supplementation among acute pneumonia patients, as shown in Table 8, indicates that half of the patients (50%) received zinc supplements while the other half did not. This even split provides a suitable framework for comparing clinical outcomes and the potential benefits of zinc supplementation in treating pneumonia.

Zinc is indispensable for optimal immune function, notably by preserving the wholeness of the respiratory epithelium and regulating inflammatory pathways. [24] Its importance in treating respiratory tract infections, including pneumonia, has been assessed in numerous clinical trial studies.

Given the 50% rate of zinc usage among the study population, it would be pertinent to analyze whether those who received supplementation experienced improved outcomes compared to those who did not. Such analysis could help determine the efficacy of routine zinc use in acute pneumonia cases and guide clinical practice.

Duration of zinc intake among pneumonia patients

Table 9 presents the duration of zinc supplementation among 80 acute pneumonia patients who received the supplement. The data indicate that 57.5% of patients received zinc for 5–10 days, while 42.5% received it for 11–16 days. This variation in duration reflects common clinical practice, where the length of supplementation may depend on illness severity, physician preference, and patient response to treatment.

Evidence suggests that the therapeutic benefits of zinc in respiratory infections, including pneumonia, are often observed when supplementation is maintained consistently over a certain period. According to Brooks et al. (2004), a 7-day course of zinc showed significant improvements in recovery time in children with severe pneumonia. [25]

This variation in practice observed in Table 4.9 may reflect attempts to individualize treatment based on patient response and clinical improvement.

Patterns of Antibiotic Administration in Acute Pneumonia

Table 10 outlines the distribution of antibiotic use among 80 acute pneumonia patients. The most commonly prescribed antibiotic was Cefixime (33.75%), followed by Amoxicillin (21.25%) and Azithromycin (17.50%). Notably, 27.50% of the patients did not receive any antibiotics. This distribution highlights the variation in prescribing practices and potentially reflects differing severity of illness, diagnostic certainty, or antimicrobial stewardship strategies. Cefixime, a third-generation oral cephalosporin, is often used for treating respiratory tract infections, especially when resistance to first-line agents is suspected. [26]

This table underscores the importance of accurate diagnosis and judicious antibiotic use in pneumonia management. It also raises questions about the criteria for withholding antibiotics in some patients, which should be supported by strong clinical judgment and diagnostic tools.

Occurrence of Side Effects in Pneumonia Patients

Table 11 presents the adverse effects observed among 160 patients with acute pneumonia. A majority of patients (56.25%) reported no adverse effects during treatment. Among those who experienced side effects, rash (16.88%) was the most common, followed by diarrhoea (14.37%) and vomiting (12.50%). These side effects are frequently associated with antibiotics and supportive medications used during pneumonia treatment. Skin rashes may occur as allergic reactions to antibiotics such as beta-lactams (e.g., amoxicillin or cefixime)

or macrolides (e.g., azithromycin). [27] Similarly, gastrointestinal symptoms like vomiting and diarrhea are well-documented side effects, particularly in pediatric populations, and are often related to disruption of gut flora or direct mucosal irritation caused by antibiotics. [28]

The relatively high percentage (56.25%) of patients without any reported side effects is reassuring and suggests good tolerability of the treatment regimens overall. However, even mild side effects can negatively impact treatment adherence, especially in children, highlighting the need for careful monitoring and patient education. [29] In clinical settings, balancing the therapeutic benefits of medications against potential adverse effects remains a key component of effective pneumonia management.

Patient hospitalization duration analysis

Table 12 presents the period of hospital stay among 160 patients with severe pneumonia. The majority of patients (55%) admitted in the hospital for 6–10 days, and 45% admitted for 1–5 days. The mean hospital stay was approximately 6 days (5.98 ± 2.71 days), indicating moderate severity in the most of the cases.

Length of hospital stay in pneumonia patients often be contingent on various factors as well as the severity of illness, the presence of comorbidities, patient age, timeliness of treatment initiation, and treatment response. [30]

Strategies such as initial change from IV to oral antibiotics and use of severity scoring systems (like CURB-65) can help optimize care and reduce hospitalization duration.

Patient recovery duration analysis

Table 13 outlines the clinical recovery time of 160 patients with acute pneumonia. A significant majority (75.63%) recovered within 2–5 days, followed by 22.50% who recovered within 6–9 days, and only 1.88% who took more than 10 days. The mean recovery time was approximately 4 days (4.01 ± 2.27), suggesting that most patients experienced a relatively swift resolution of symptoms.

Quick recovery times can be attributed to timely diagnosis, appropriate antibiotic therapy, and effective supportive care. Early clinical response is a favourable prognostic marker in pneumonia management and typically occurs within 48–72 hours of treatment initiation. Factors influencing faster recovery include younger age, absence of comorbidities, and mild-to-moderate disease severity at presentation. [31]

Recovery rate and outcomes in acute pneumonia

Table 14 presents the clinical recovery outcomes among 160 patients with acute pneumonia. A substantial majority—96.25% (n=154)—fully recov-

ered, while only 3.75% (n=6) did not show clinical recovery during the study period. This high recovery rate indicates the effectiveness of the current treatment protocols, which likely included timely administration of antibiotics, zinc supplementation, and supportive care. The impressive recovery percentage aligns with global data suggesting that with early intervention and appropriate care, most patients with acute pneumonia—especially in paediatric and otherwise healthy populations—recover without severe complications. However, the small group that did not recover might have had contributing factors such as comorbidities, delayed diagnosis, or antibiotic resistance, which are known to impede pneumonia recovery. [31, 32]

Evaluating risk factors and clinical recovery in acute pneumonia: a comparative study of zinc supplemented and non-supplemented patients

The results indicate no significant clinical or physiological alterations between the zinc and non-zinc groups for most variables, suggesting that zinc supplementation did not drastically alter basic vital signs or immediate clinical outcomes in this sample. This is in lined with mixed outcomes in the literature regarding the role of zinc in pneumonia management. Zinc is known to support immune role and epithelial integrity, particularly in children. [33] Yet its direct effect on acute symptom resolution remains debated.

Zinc supplementation and its association with risk factors and recovery in acute pneumonia patients: a comparative study

Table 4.16 presents a comparison of key clinical risk factors and outcomes between acute pneumonia children administered zinc supplements compared with those unadministered. There were no statistically significant differences observed across gender (p=1.00), chest in-drawing (p=0.75), feeding difficulty (p=0.87), or treatment outcomes (p=0.40). This indicates that the distribution of baseline risk factors was comparable between both groups, thus minimizing potential confounding effects related to these variables.

The equality in gender distribution (41 females and 39 males in both groups) ensures balanced demographic representation. Similarly, clinical indicators such as chest in-drawing and feeding difficulty—key signs of pneumonia severity were evenly distributed. [34] This supports the internal validity of any observed differences in outcomes such as recovery time or hospital stay in related tables. In clinical settings with standard treatment protocols, the function of zinc as an adjunct treatment may offer modest or negligible benefits, especially in cases without severe complications.

Impact of zinc supplementation on antibiotic usage patterns and adverse reactions in acute pneumonia patients

The antibiotic prescription pattern did not vary significantly between the zinc and non-zinc groups, indicating that zinc supplementation was likely administered independently of antibiotic choice. This uniformity helps isolate zinc's effects when interpreting adverse measures. The zinc group exhibited a markedly greater incidence of contrary effects, particularly rash, diarrhoea, and vomiting, with statistical significance ($p \leq 0.001$). While zinc is generally considered safe, its gastrointestinal side effects—especially at higher or prolonged dosages—are well documented. [25, 35] Skin reactions like rash are less common but can occur due to hypersensitivity or individual intolerance. [36] These findings emphasize the importance of monitoring for side effects when administering zinc, particularly in younger or nutritionally vulnerable populations. The notably greater percentage of patients in the non-zinc group who experienced no adverse effects (95%) further reinforces zinc's potential to cause mild to moderate side effects.

Conclusion

This study underscores the persistent burden of acute pneumonia in children under five, especially in resource-limited settings where undernutrition and limited access to care prevail. Despite advances in treatment, pneumonia-related morbidity remains high, prompting the exploration of adjunctive therapies like zinc. While zinc supplementation demonstrated modest potential in improving clinical outcomes such as fever resolution, respiratory normalization, and hospital stay, the results were not statistically significant. Nonetheless, its known immunological benefits and affordability support its continued evaluation, particularly in malnourished populations. The study also highlights the importance of early diagnosis, symptom monitoring, rational antibiotic use, and nutritional assessment in improving recovery. Future large-scale research is warranted to determine zinc's definitive role in paediatric pneumonia management and to establish evidence-based guidelines for its optimal use.

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