

Factors associated with prolonged hospitalization among under-five children with community-acquired pneumonia: A cross-sectional observational study.

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Abstract

Background:

Prolonged hospitalization among under-five children with community-acquired pneumonia (CAP) increases healthcare utilization and socioeconomic burden.

Objective:

To assess sociodemographic, nutritional, environmental, clinical, laboratory, treatment-related, and adverse drug reaction (ADR)-related factors associated with prolonged hospitalization among under-five children with CAP.

Methods:

A hospital-based cross-sectional observational study was conducted in the Department of Paediatrics in collaboration with the Department of Pharmacology and Therapeutics, M.K.C.G. Medical College and Hospital, Berhampur, Odisha, India, from August 2023 to September 2024. A total of 118 children aged 2–59 months with CAP were enrolled consecutively. Hospitalization >7 days was considered prolonged. Categorical variables were analysed using Pearson's chi-square and Fisher's exact tests, as applicable. Associations were expressed as unadjusted odds ratios (ORs) with 95% confidence intervals (CIs).

Results:

Of 118 children, 44 (37.3%) experienced prolonged hospitalization. Higher family income was associated with lower odds of prolonged stay (OR=0.294; 95% CI: 0.115–0.746), whereas larger household size increased the odds (OR=2.465; 95% CI: 1.127–5.394). Breastfeeding (OR=0.176; 95% CI: 0.034–0.914), hand hygiene (OR=0.352; 95% CI: 0.155–0.799), and toilet use (OR=0.316; 95% CI: 0.139–0.717) were protective, while malnutrition (OR=2.174; 95% CI: 1.010–4.673), grunting (OR=3.300; 95% CI: 1.148–9.488), abdominal pain (OR=11.526; 95% CI: 1.339–99.253), and TLC >15 (OR=4.181; 95% CI: 1.887–9.266) were associated with prolonged hospitalization. Hemoglobin >10 was protective (OR=0.250; 95% CI: 0.108–0.579). ADR status was not significantly associated with prolonged hospitalization (p=0.931).

Conclusion:

Prolonged hospitalization was associated with socioeconomic, nutritional, clinical, and laboratory factors.

Recommendation:

Early identification of these factors may facilitate risk stratification, closer monitoring, nutritional support, and appropriate clinical management to reduce prolonged hospitalization.

Keywords: Community-acquired pneumonia; Under-five children; Prolonged hospitalization; Length of hospital stay; Malnutrition; Breastfeeding; Anemia; Leukocytosis; Risk factors.

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Introduction

Community-acquired pneumonia (CAP) remains a major cause of morbidity, hospitalization, and mortality among children younger than five years, with the burden disproportionately concentrated in low- and middle-income countries. Young children are particularly vulnerable because of their relatively immature immune responses, smaller airways, nutritional susceptibility, and greater likelihood of rapid progression from uncomplicated respiratory infection to hypoxemia and severe disease. Hospital-based studies from India continue to demonstrate a substantial burden of severe CAP among children aged 2–59 months, with infancy, malnutrition, incomplete immunization, adverse environmental exposures, and underlying illnesses contributing to greater disease severity and poorer clinical outcomes.[1-4]

The clinical course of childhood CAP is heterogeneous. While many hospitalized children show rapid clinical improvement following appropriate antimicrobial therapy and supportive management, a clinically important proportion require a longer period of hospitalization. Length of hospital stay represents an important outcome because it reflects not only the severity and evolution of the underlying infection but also the presence of complications, comorbidities, nutritional vulnerability, response to treatment, and requirement for supportive interventions. Prolonged hospitalization additionally increases utilization of hospital beds, antimicrobial exposure, diagnostic investigations, treatment costs, and the socioeconomic burden imposed on families. Identifying children at increased risk of an extended hospital stay at the time of admission may therefore facilitate appropriate risk stratification, closer monitoring, rational allocation of healthcare resources, and more informed counselling of caregivers.

Several demographic, nutritional, environmental, clinical, and radiological characteristics have been associated with adverse outcomes in childhood pneumonia. In an Indian prospective hospital-based study, Kasundriya et al. observed that prematurity, incomplete vaccination, congenital heart disease, prior home treatment, overcrowding, poor household ventilation, and adverse living conditions were independently associated with severe pneumonia among children aged 2 months to 5 years.[1] Similarly, a large multicentre observational study of hospitalized children

with CAP in northern India demonstrated that severe malnutrition, comorbidity, pallor, tachypnea, general danger signs, abnormal radiological findings, and other markers of disease severity were associated with hypoxic pneumonia. Importantly, hypoxia was associated with more than a twofold increase in the odds of mortality.[2] These observations emphasize that childhood CAP outcomes are determined by an interaction between the severity of the acute respiratory illness and the child's underlying biological and socioeconomic vulnerability.

Evidence specifically examining the duration of hospitalization has identified additional determinants. In a prospective study of 200 Indian children aged 2–60 months hospitalized with severe pneumonia, Tiewsoh et al. reported that 51% required hospitalization for more than five days. Lack of exclusive breastfeeding, household overcrowding, and abnormal chest radiography were independently associated with prolonged hospital stay. Among children with radiographically confirmed pneumonia, lower maternal education, absence of exclusive breastfeeding, and oxygen saturation below 90% at presentation were important determinants of longer hospitalization.[5] More recently, a multicentre study of children aged 2–59 months with severe CAP in Ethiopia identified wasting, anemia, late presentation, pleural effusion, referral from another healthcare facility, and selected deficiencies in diagnostic evaluation as significant predictors of delayed recovery and prolonged hospitalization.[6]

Radiological and complication-related characteristics are also relevant to the subsequent course of CAP. A large prospective multisite Indian study involving children aged 2–59 months hospitalized with CAP found radiographic abnormalities in approximately one-third of interpretable chest radiographs; abnormalities were more frequent among malnourished children and those with a longer duration of illness.[7] An observational study conducted in Odisha similarly documented clinically important complications, including sepsis, congestive cardiac failure, and empyema, among children hospitalized with severe and very severe pneumonia and reported poorer outcomes among children presenting later in the course of illness.[8] Delayed healthcare seeking may allow progression of pneumonia before initiation of effective treatment; an Indian prospective study by Yadav and Awasthi demonstrated that delayed care seeking was common among hospitalized

children with severe CAP and was strongly associated with complicated disease.[9] These findings collectively suggest that timely presentation, nutritional status, initial severity, hypoxemia, radiological involvement, and complications may influence both clinical recovery and duration of hospitalization.

Recent evidence further supports the clinical importance of examining prolonged hospitalization as a distinct outcome. Alharbi et al., in a study of 455 children hospitalized with CAP, reported prolonged hospitalization in 27.5% of patients. Moderate-to-severe pneumonia, pneumonia-related complications, and underlying chronic medical conditions were independently associated with prolonged stay, while hypoxia, ventilatory support, and bacteraemia were significantly more frequent among children requiring extended hospitalization.[10] The findings reinforce the concept that hospital length of stay is influenced by a combination of disease severity, host factors, complications, and treatment requirements rather than by any single clinical characteristic. [10]

However, the factors determining prolonged hospitalization may vary substantially across populations because of differences in nutritional status, immunization coverage, healthcare-seeking behaviour, antimicrobial exposure before admission, referral practices, socioeconomic circumstances, prevalence of comorbidities, and availability of diagnostic and supportive care. Although several Indian studies have investigated risk factors for severe pneumonia, hypoxemia, complications, and mortality, comparatively fewer studies have specifically evaluated the factors associated with prolonged hospitalization among under-five children with CAP. Furthermore, evidence from other geographical and healthcare settings cannot necessarily be extrapolated directly to the local paediatric population.

Identification of readily measurable factors associated with prolonged hospital stay could enable clinicians to recognize high-risk children early during hospitalization and intensify appropriate monitoring and supportive care. It may also aid discharge planning, optimize utilization of paediatric beds and healthcare resources, and provide clinically useful prognostic information to caregivers. Therefore, the present study was undertaken **to identify the factors associated with prolonged hospitalization among under-five children admitted with community-acquired pneumonia.** The study aimed to assess the association of relevant sociodemographic, nutritional, clinical, laboratory, treatment-related, and complication-related characteristics with the duration of hospital stay and to determine the

factors associated with prolonged hospitalization in these children.

Materials and Methods

Study Design, Setting and Duration

This hospital-based cross-sectional observational study was conducted in the Department of Paediatrics, in collaboration with the Department of Pharmacology and Therapeutics, M.K.C.G. Medical College and Hospital, Berhampur, Odisha, India, from August 2023 to September 2024. M.K.C.G. Medical College and Hospital is a tertiary-care teaching and referral institution providing specialist and superspecialist healthcare services to patients from southern Odisha and adjoining regions. The Department of Paediatrics provides inpatient and outpatient paediatric services, including care for children requiring hospitalization for acute respiratory illnesses such as community-acquired pneumonia. The study included children aged 2–59 months admitted with community-acquired pneumonia who fulfilled the predefined eligibility criteria.

Study Population

The study population comprised hospitalized children aged 2–59 months with community-acquired pneumonia. Participants were selected using consecutive sampling. All children admitted to the Department of Paediatrics during the study period were assessed for eligibility according to the predefined inclusion and exclusion criteria. Eligible children whose parents or legally authorized representatives provided written informed consent were enrolled consecutively until the required sample size of 118 participants was achieved.

Sample Size Calculation

The sample size was estimated based on the expected proportion of prolonged hospitalization among children admitted with community-acquired pneumonia. Based on a previously published study by Tiewsoh et al., approximately 51% of children hospitalized with severe pneumonia had a prolonged hospital stay. Considering an anticipated proportion of 51%, a 95% confidence level, and an absolute precision of 9%, the minimum required sample size was estimated to be approximately 118 participants. Accordingly, a total of 118 eligible under-five children with community-acquired pneumonia were included in the present study.

Sample Size and Sampling

A total of **118 children** fulfilling the eligibility criteria were included in the study. Eligible children admitted during the study period were enrolled using a consecutive sampling method until the required sample size was attained.

Eligibility Criteria

Children aged **2–59 months** admitted to the Department of Paediatrics with a clinical diagnosis of community-acquired pneumonia and whose parents or legally authorized representatives provided informed consent were eligible for inclusion.

Children with hospital-acquired pneumonia, those who developed pneumonia after hospitalization for another primary illness, and those whose essential clinical information or duration of hospital stay could not be reliably determined were excluded from the study. Children whose parents or legally authorized representatives declined participation were also excluded.

Diagnosis of Community-Acquired Pneumonia

Community-acquired pneumonia was diagnosed on the basis of clinical presentation and findings documented by the treating paediatric team, in accordance with the prevailing institutional and standard clinical criteria for childhood pneumonia. Relevant symptoms and signs, including cough, difficulty in breathing, fever, age-specific tachypnoea, chest indrawing, abnormal respiratory findings, hypoxaemia, and general danger signs, were documented wherever applicable. Laboratory and radiological investigations were performed according to clinical indications and routine institutional practice.

Data Collection

Data were collected using a structured case-record form from the child's caregiver, clinical examination findings, inpatient case records, investigation reports, treatment charts, and discharge records. Information was recorded at admission and during hospitalization without interfering with routine patient management.

The variables recorded included relevant **sociodemographic characteristics**, such as age, sex,; **nutritional and anthropometric characteristics**, including weight and nutritional status; and relevant clinical history, including duration of symptoms before hospitalization, previous treatment, immunization status,

feeding history, and associated illnesses, wherever available.

Clinical characteristics recorded at admission included presenting symptoms, respiratory rate, presence of respiratory distress or chest indrawing, oxygen saturation, fever, danger signs, severity of pneumonia, and other relevant examination findings. Available laboratory and radiological findings were also documented.

Treatment-related information included the antimicrobial agents administered, use of a **single antibiotic or multiple antibiotics**, oxygen supplementation, supportive therapy, and other clinically indicated interventions. Adverse drug reactions occurring during hospitalization, associated complications, and relevant clinical outcomes were also documented.

Assessment of Hospital Stay

The duration of hospitalization was calculated from the date of admission to the date of discharge and expressed in completed days. For the principal analysis, the study participants were categorized into two groups according to the duration of hospitalization: **≤7 days (non-prolonged hospitalization)** and **>7 days (prolonged hospitalization)**. Accordingly, a hospital stay exceeding 7 days was considered the primary outcome of interest. Demographic, birth-related, nutritional, preventive, household, environmental, clinical, laboratory, treatment-related, adverse drug reaction, and clinical outcome characteristics were compared between children with prolonged hospitalization and those hospitalized for 7 days or less.

Outcome Measures

The **primary outcome** of the study was prolonged hospitalization, defined as a hospital stay of **>7 days**.

The study evaluated the association of prolonged hospitalization with potential sociodemographic and birth-related characteristics, nutritional and preventive factors, household and environmental characteristics, clinical signs and symptoms, laboratory and physiological parameters, treatment-related characteristics, adverse drug reactions, and clinical outcomes.

Bias

Several measures were undertaken to minimize potential sources of bias. Selection bias was reduced by consecutively enrolling all eligible children during the study period until the required sample size was achieved. Standard predefined eligibility criteria were applied uniformly to all participants. Information bias was minimized by collecting data using a

structured case-record form from multiple sources, including caregiver interviews, clinical examination findings, inpatient case records, investigation reports, treatment charts, and discharge records. Clinical and laboratory information was recorded using routinely documented hospital data. Data were checked for completeness and consistency before statistical analysis. Nevertheless, residual confounding and information bias inherent to the observational study design could not be completely excluded.

Ethical Consideration

The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC), M.K.C.G. Medical College, Berhampur, Odisha, India (Approval No. 1142/Chairman-IEC, M.K.C.G. Medical College, Berhampur-4, dated 13 July 2022). Written informed consent was obtained from the parent or legally authorized representative of each participating child before enrolment. Participation was voluntary, and confidentiality and privacy of participant information were maintained throughout the study.

Ethical Approval

The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC), M.K.C.G. Medical College, Berhampur, Odisha, India (Approval No. 1142/Chairman-IEC, M.K.C.G. Medical College, Berhampur-4, dated 13.07.2022). The study was conducted

in accordance with applicable ethical principles for research involving human participants.

Informed Consent

Written informed consent was obtained from the parent or legally authorized representative of each participating child before enrolment in the study. Participation was voluntary, and confidentiality and privacy of participant information were maintained throughout the study.

Statistical Analysis

Data were entered into Microsoft Excel, checked for completeness and consistency, and analyzed using SPSS version 22.0. Categorical variables were summarized as frequencies and percentages [n (%)]. Duration of hospitalization was categorized as ≤ 7 days and > 7 days, with a hospital stay of > 7 days considered prolonged hospitalization.

Associations between prolonged hospitalization and sociodemographic, birth-related, nutritional, preventive, household, environmental, clinical, laboratory, treatment-related, clinical outcome, and adverse drug reaction variables were assessed. Pearson's chi-square (χ^2) test and Fisher's exact test were used to assess associations between categorical variables, with Fisher's exact test applied when expected cell frequencies were small. The strength of association between individual factors and prolonged hospitalization was expressed as unadjusted odds ratios (ORs) with 95% confidence intervals (CIs), using an appropriate category as the reference. All statistical tests were two-tailed, and a p-value < 0.05 was considered statistically significant.

Results

Table 1: Association of Sociodemographic and Birth-Related Characteristics with Duration of Hospital Stay Among Under-Five Children with Community-Acquired Pneumonia

Variable	Category	Hospital Stay ≤ 7 days, n (%)	Hospital Stay > 7 days, n (%)	Total, n (%)	Odds ratio (95% CI)	χ^2 /Fisher; p value
Age group	2–12 months	44 (62.0)	27 (38.0)	71 (100.0)	Reference	0.042; 0.838
	13–60 months	30 (63.8)	17 (36.2)	47 (100.0)	0.923 (0.430–1.982)	
Sex	Female	15 (51.7)	14 (48.3)	29 (100.0)	Reference	1.985; 0.159
	Male	59 (66.3)	30 (33.7)	89 (100.0)	0.545 (0.233–1.276)	

Birth weight	Low birth weight	39 (57.4)	29 (42.6)	68 (100.0)	Reference	1.971; 0.160
	Normal birth weight	35 (70.0)	15 (30.0)	50 (100.0)	0.576 (0.266–1.248)	
Monthly income	<₹20,000	45 (54.9)	37 (45.1)	82 (100.0)	Reference	7.054; 0.008*
	>₹20,000	29 (80.6)	7 (19.4)	36 (100.0)	0.294 (0.115–0.746)	
Household size	<5 people	54 (70.1)	23 (29.9)	77 (100.0)	Reference	5.215; 0.022*
	>5 people	20 (48.8)	21 (51.2)	41 (100.0)	2.465 (1.127–5.394)	

*Note. Odds ratios represent the odds of hospital stay >7 days relative to the stated reference category. *Statistically significant at $p < .05$. Fisher's exact test is shown where applicable.*

Table 1 showed the association of sociodemographic and birth-related characteristics with duration of hospital stay among 118 under-five children with community-acquired pneumonia. Monthly income and household size were significantly associated with prolonged hospitalization (>7 days). Children from families with a monthly income >₹20,000 had significantly lower odds of prolonged hospitalization than those with an income <₹20,000 (OR =

0.294; 95% CI: 0.115–0.746; $p = 0.008$). Children living in households with >5 members had significantly higher odds of prolonged hospitalization compared with those living in households with <5 members (OR = 2.465; 95% CI: 1.127–5.394; $p = 0.022$). Age group, sex, and birth weight were not significantly associated with duration of hospital stay ($p > 0.05$).

Table 2: Association of Nutritional, Preventive and Household Health Practices with Duration of Hospital Stay Among Under-Five Children with Community-Acquired Pneumonia

Variable	Category	Hospital stay ≤7 days, n (%)	Hospital stay >7 days, n (%)	Total, n (%)	Odds ratio (95% CI)	χ^2 /Fisher; p value
Breastfeeding	No	2 (25.0)	6 (75.0)	8 (100.0)	Reference	5.219; 0.022*
	Yes	72 (65.5)	38 (34.5)	110 (100.0)	0.176 (0.034–0.914)	
Malnutrition	Absent	41 (71.9)	16 (28.1)	57 (100.0)	Reference	4.007; 0.045*
	Present	33 (54.1)	28 (45.9)	61 (100.0)	2.174 (1.010–4.673)	
Immunization status	No	12 (52.2)	11 (47.8)	23 (100.0)	Reference	1.357; 0.244
	Yes	62 (65.3)	33 (34.7)	95 (100.0)	0.581 (0.231–1.458)	
Vitamin supplementation	A No	27 (55.1)	22 (44.9)	49 (100.0)	Reference	2.075; 0.150
	Yes	47 (68.1)	22 (31.9)	69 (100.0)	0.574 (0.269–1.225)	
Safe drinking water consumption	No	49 (58.3)	35 (41.7)	84 (100.0)	Reference	2.390; 0.122
	Yes	25 (73.5)	9 (26.5)	34 (100.0)	0.504 (0.210–1.211)	
Hand hygiene	No	38 (53.5)	33 (46.5)	71 (100.0)	Reference	6.439; 0.011*

Toilet use	Yes	36 (76.6)	11 (23.4)	47 (100.0)	0.352 (0.155–0.799)	7.891; 0.005*
	No	36 (52.2)	33 (47.8)	69 (100.0)	Reference	
	Yes	38 (77.6)	11 (22.4)	49 (100.0)	0.316 (0.139–0.717)	

*Note. Odds ratios represent the odds of hospital stay >7 days relative to the stated reference category. *Statistically significant at $p < .05$. Fisher's exact test is shown where applicable.*

Table 2 showed the association of nutritional, preventive, and household health practices with duration of hospital stay among under-five children with community-acquired pneumonia. Breastfeeding, malnutrition, hand hygiene, and toilet use were significantly associated with prolonged hospitalization (>7 days). Breastfed children had significantly lower odds of prolonged hospitalization than non-breastfed children (OR = 0.176; 95% CI: 0.034–0.914; $p = 0.022$). Malnourished children had significantly higher

odds of prolonged hospitalization compared with those without malnutrition (OR = 2.174; 95% CI: 1.010–4.673; $p = 0.045$). Similarly, hand hygiene (OR = 0.352; 95% CI: 0.155–0.799; $p = 0.011$) and toilet use (OR = 0.316; 95% CI: 0.139–0.717; $p = 0.005$) were associated with significantly lower odds of prolonged hospitalization. Immunization status, vitamin A supplementation, and safe drinking water consumption were not significantly associated with duration of hospital stay ($p > 0.05$).

Table 3: Association of Environmental Exposures with Duration of Hospital Stay Among Under-Five Children with Community-Acquired Pneumonia

Variable	Category	Hospital stay ≤ 7 days, n (%)	Hospital stay >7 days, n (%)	Total, n (%)	Odds (95% CI)	ratio	χ^2 /Fisher; p value
Cooking exposure	fuel No	23 (69.7)	10 (30.3)	33 (100.0)	Reference		0.956; 0.328
	Yes	51 (60.0)	34 (40.0)	85 (100.0)	1.533 (0.649–3.623)		
Parental smoking	No	11 (68.8)	5 (31.3)	16 (100.0)	Reference		0.289; 0.591
	Yes	63 (61.8)	39 (38.2)	102 (100.0)	1.362 (0.440–4.216)		

*Note. Odds ratios represent the odds of hospital stay >7 days relative to the stated reference category. *Statistically significant at $p < .05$. Fisher's exact test is shown where applicable.*

Table 3 displays the association of environmental exposures with duration of hospital stay among under-five children with community-acquired pneumonia. A higher proportion of children exposed to cooking fuel had prolonged hospitalization (>7 days) compared with those without such exposure (40.0% vs. 30.3%); however, the association was not statistically significant (OR = 1.533; 95% CI: 0.649–3.623; $p = 0.328$). Similarly, prolonged hospitalization was

more frequent among children exposed to parental smoking than among those without parental smoking exposure (38.2% vs. 31.3%), but this association was also not statistically significant (OR = 1.362; 95% CI: 0.440–4.216; $p = 0.591$). Thus, neither cooking fuel exposure nor parental smoking was significantly associated with duration of hospital stay ($p > 0.05$).

Table 4: Association of Clinical Signs and Symptoms with Duration of Hospital Stay Among Under-Five Children with Community-Acquired Pneumonia

Variable	Category	Hospital stay ≤7 days, n (%)	Hospital stay >7 days, n (%)	Total, n (%)	Odds ratio (95% CI)	χ ² /Fisher; p value
Fever	No	9 (69.2)	4 (30.8)	13 (100.0)	Reference	Fisher; 0.765
	Yes	65 (61.9)	40 (38.1)	105 (100.0)	1.385 (0.400–4.794)	
Cough	No	3 (75.0)	1 (25.0)	4 (100.0)	Reference	Fisher; 1.000
	Yes	71 (62.3)	43 (37.7)	114 (100.0)	1.817 (0.183–18.026)	
Rapid breathing	Absent	11 (47.8)	12 (52.2)	23 (100.0)	Reference	2.707; 0.100
	Present	63 (66.3)	32 (33.7)	95 (100.0)	0.466 (0.185–1.171)	
Grunting	Absent	22 (81.5)	5 (18.5)	27 (100.0)	Reference	5.275; 0.022*
	Present	52 (57.1)	39 (42.9)	91 (100.0)	3.300 (1.148–9.488)	
Chest indrawing	Absent	60 (63.8)	34 (36.2)	94 (100.0)	Reference	0.247; 0.619
	Present	14 (58.3)	10 (41.7)	24 (100.0)	1.261 (0.505–3.144)	
Vomiting	No	61 (61.6)	38 (38.4)	99 (100.0)	Reference	0.316; 0.574
	Yes	13 (68.4)	6 (31.6)	19 (100.0)	0.741 (0.260–2.115)	
Chest pain	No	73 (62.9)	43 (37.1)	116 (100.0)	Reference	Fisher; 1.000
	Yes	1 (50.0)	1 (50.0)	2 (100.0)	1.698 (0.104–27.844)	
Abdominal pain	No	73 (65.8)	38 (34.2)	111 (100.0)	Reference	Fisher; 0.011*
	Yes	1 (14.3)	6 (85.7)	7 (100.0)	11.526 (1.339–99.253)	

*Note. Odds ratios represent the odds of hospital stay >7 days relative to the stated reference category. *Statistically significant at p < .05. Fisher's exact test is shown where applicable.*

Table 4 depicts the association of clinical signs and symptoms with duration of hospital stay among under-five children with community-acquired pneumonia. Grunting and abdominal pain were significantly associated with prolonged hospitalization (>7 days). Children presenting with grunting had significantly higher odds of prolonged hospitalization compared with those without grunting (OR

= 3.300; 95% CI: 1.148–9.488; p = 0.022). Similarly, children with abdominal pain had markedly higher odds of prolonged hospitalization than those without abdominal pain (OR = 11.526; 95% CI: 1.339–99.253; p = 0.011). Fever, cough, rapid breathing, chest indrawing, vomiting, and chest pain were not significantly associated with duration of hospital stay (p > 0.05).

Table 5: Association of Laboratory and Physiological Parameters with Duration of Hospital Stay Among Under-Five Children with Community-Acquired Pneumonia

Variable	Category	Hospital stay ≤ 7 days, n (%)	Hospital stay > 7 days, n (%)	Total, n (%)	Odds ratio (95% CI)	χ^2 /Fisher; p value
Respiratory rate	$< 55/\text{min}$	36 (61.0)	23 (39.0)	59 (100.0)	Reference	0.145; 0.703
	$> 55/\text{min}$	38 (64.4)	21 (35.6)	59 (100.0)	0.865 (0.410–1.825)	
Total leukocyte count (TLC)	≤ 14	55 (75.3)	18 (24.7)	73 (100.0)	Reference	13.059; $< 0.001^*$
	> 15	19 (42.2)	26 (57.8)	45 (100.0)	4.181 (1.887–9.266)	
Hemoglobin level	≤ 10	34 (50.0)	34 (50.0)	68 (100.0)	Reference	11.090; $< 0.001^*$
	> 10	40 (80.0)	10 (20.0)	50 (100.0)	0.250 (0.108–0.579)	

*Note. Odds ratios represent the odds of hospital stay > 7 days relative to the stated reference category. *Statistically significant at $p < .05$. Fisher's exact test is shown where applicable.*

Table 5 showed the association of laboratory and physiological parameters with duration of hospital stay among under-five children with community-acquired pneumonia. Total leukocyte count (TLC) and hemoglobin level were significantly associated with prolonged hospitalization (> 7 days). Children with a TLC > 15 had significantly higher odds of prolonged hospitalization compared with those having a TLC ≤ 14 (OR = 4.181; 95%

CI: 1.887–9.266; $p < 0.001$). In contrast, children with a hemoglobin level > 10 had significantly lower odds of prolonged hospitalization than those with a hemoglobin level ≤ 10 (OR = 0.250; 95% CI: 0.108–0.579; $p < 0.001$). Respiratory rate was not significantly associated with duration of hospital stay (OR = 0.865; 95% CI: 0.410–1.825; $p = 0.703$).

Table 6: Association of Treatment and Clinical Outcome with Duration of Hospital Stay Among Under-Five Children with Community-Acquired Pneumonia

Variable	Category	Hospital stay ≤ 7 days, n (%)	Hospital stay > 7 days, n (%)	Total, n (%)	Odds ratio (95% CI)	χ^2 /Fisher; p value
Number of antibiotics used	≤ 2 antibiotics	64 (65.3)	34 (34.7)	98 (100.0)	Reference	1.664; 0.197
	> 2 antibiotics	10 (50.0)	10 (50.0)	20 (100.0)	1.882 (0.713–4.967)	
Clinical outcome	Shifted to ICU	4 (28.6)	10 (71.4)	14 (100.0)	Reference	7.918; 0.005*
	Cured	70 (67.3)	34 (32.7)	104 (100.0)	0.194 (0.057–0.665)	

*Note. Odds ratios represent the odds of hospital stay > 7 days relative to the stated reference category. *Statistically significant at $p < .05$. Fisher's exact test is shown where applicable.*

Table 6 depicts the association of treatment-related factors and clinical outcome with duration of hospital stay among

under-five children with community-acquired pneumonia. Clinical outcome was significantly associated with

prolonged hospitalization (>7 days). Children who were cured had significantly lower odds of prolonged hospitalization compared with those who were shifted to the ICU (OR = 0.194; 95% CI: 0.057–0.665; $p = 0.005$). Among children receiving >2 antibiotics, 50.0% had a hospital stay

>7 days compared with 34.7% of those receiving ≤ 2 antibiotics; however, the number of antibiotics used was not significantly associated with duration of hospital stay (OR = 1.882; 95% CI: 0.713–4.967; $p = 0.197$).

Table 7: Association of Adverse Drug Reaction (ADR) Status with Duration of Hospital Stay Among Under-Five Children with Community-Acquired Pneumonia

ADR status	Hospital stay ≤ 7 days, n (%)	Hospital stay >7 days, n (%)	Total, n (%)	Odds ratio (95% CI)	χ^2 ; p value
Absent	46 (63.0)	27 (37.0)	73 (100.0)	Reference	
Present	28 (62.2)	17 (37.8)	45 (100.0)	1.034 (0.480–2.228)	0.007; 0.931
Total	74 (62.7)	44 (37.3)	118 (100.0)		

Note. Odds ratios represent the odds of hospital stay >7 days relative to the stated reference category. ADR = adverse drug reaction. Statistical significance was set at $p < .05$.

Table 7 displayed the association between adverse drug reaction (ADR) status and duration of hospital stay among under-five children with community-acquired pneumonia. Prolonged hospitalization (>7 days) occurred in 37.8% of children who experienced an ADR compared with 37.0% of those without an ADR. The odds of prolonged hospitalization were nearly similar between children with and without ADRs (OR = 1.034; 95% CI: 0.480–2.228). ADR status was not significantly associated with duration of hospital stay ($\chi^2 = 0.007$; $p = 0.931$).

Discussion

The present study evaluated sociodemographic, nutritional, environmental, clinical, laboratory, treatment-related, and adverse drug reaction factors associated with prolonged hospitalization among under-five children admitted with community-acquired pneumonia (CAP). Of the 118 children, 44 (37.3%) required hospitalization for more than 7 days. Significant associations with prolonged hospitalization were observed for lower monthly family income, larger household size, absence of breastfeeding, malnutrition, lack of hand hygiene and toilet use, grunting, abdominal pain, higher total leukocyte count (TLC), lower haemoglobin level, and clinical outcome. In contrast, age, sex, birth weight, environmental smoke exposure, several common respiratory symptoms, respiratory rate, number of antibiotics used, and ADR occurrence were not significantly associated with prolonged hospital stay.

The proportion of prolonged hospitalization observed in this study was broadly comparable with previous studies, although direct comparison requires caution because

definitions of prolonged stay differed. Tiewsoh et al. studied 200 Indian children aged 2–60 months hospitalized with severe pneumonia and reported that 51% remained hospitalized for more than 5 days. They identified lack of exclusive breastfeeding, overcrowding, and abnormal chest radiography as determinants of prolonged stay. [5] Dinku et al., in a multicentre study of 526 children aged 2–59 months with severe CAP in Ethiopia, reported prolonged hospitalization (>5 days) in 28.9% and identified wasting, anaemia, late presentation, pleural effusion, and absence of selected investigations as significant predictors. [6] More recently, Alharbi et al. reported prolonged hospitalization, defined as ≥ 10 days, in 27.5% of 455 children with CAP; moderate-to-severe pneumonia, pneumonia-related complications, and underlying chronic conditions independently predicted extended hospitalization. [10] Collectively, these findings indicate that the observed frequency of prolonged hospitalization varies substantially according to the population studied, disease severity, healthcare setting, and the length-of-stay threshold applied.

Sociodemographic and birth-related factors

Age and sex were not significantly associated with prolonged hospitalization. This finding was consistent with the recent study by Alharbi et al., in which age and sex did not differ significantly between children with shorter and prolonged hospitalization, and neither remained a significant predictor in multivariable analysis. [10] Similarly, an Odisha-based prospective study by Champatiray et al. found no significant differences in age or sex between children with severe and very severe

pneumonia. [8] Thus, demographic characteristics alone may have limited discriminatory value for predicting the duration of hospitalization once a child has developed pneumonia requiring inpatient management.

Lower monthly family income was significantly associated with prolonged hospitalization. Children from families earning >₹20,000 per month had approximately 71% lower odds of prolonged hospitalization than those from lower-income households. This observation was consistent with evidence linking socioeconomic disadvantage with greater severity of childhood CAP. In a cohort study of children with CAP, lower family income was associated with a greater likelihood of severe disease. [11] Socioeconomic disadvantage may act through several interrelated pathways, including poorer baseline nutritional status, household crowding, delayed healthcare seeking, reduced access to preventive services, and greater exposure to environmental hazards.

Household size also showed a significant relationship with hospitalization duration; children from households with more than five members had approximately 2.5-fold higher odds of prolonged stay. This finding closely corresponded with Tiewsoh et al., who identified overcrowding as a determinant of prolonged hospitalization among Indian children with severe pneumonia (RR = 2.59). [5] Larger household size is not synonymous with overcrowding, but the two may overlap and can reflect greater opportunities for respiratory pathogen transmission as well as socioeconomic constraints. The concordance with the earlier Indian study strengthens the relevance of household conditions when assessing children at risk of a more prolonged course.

Low birth weight, however, was not significantly associated with prolonged hospitalization. Tiewsoh et al. similarly did not establish low birth weight as a determinant of prolonged stay in the overall cohort, although among children with radiographically confirmed pneumonia it was associated with the need for a change in antibiotic therapy. [5] This suggests that low birth weight may influence susceptibility or aspects of disease course without necessarily translating directly into longer hospitalization in every population.

Nutritional and preventive factors

Breastfeeding demonstrated one of the strongest protective associations in the study. Prolonged hospitalization occurred in 75.0% of non-breastfed children compared with 34.5% of breastfed children, and breastfeeding was associated with substantially reduced odds of a hospital stay exceeding 7 days. This finding strongly agreed with Tiewsoh et al., who reported lack of exclusive breastfeeding as an important

determinant of prolonged hospitalization in severe childhood pneumonia. [5] Kasundriya et al. also identified non-exclusive breastfeeding during the first 6 months as a factor associated with severe pneumonia among hospitalized Indian children. [1] These findings support the biological plausibility that breastfeeding, through nutritional adequacy and immunological protection, may contribute to a less severe clinical course and faster recovery from respiratory infection.

Malnutrition was associated with more than twice the odds of prolonged hospitalization. This result was consistent with Dinku et al., who identified wasting as a significant predictor of delayed recovery among children with severe CAP. [6] A rural childhood pneumonia study similarly reported longer hospitalization among malnourished children, particularly those with severe wasting or oedematous protein-energy malnutrition. [12] Furthermore, the large multicentre Indian study by Awasthi et al. found severe malnutrition to be associated with hypoxic CAP, an important marker of disease severity. [2] Malnutrition can impair cellular and humoral immune responses, compromise respiratory muscle function, and delay tissue recovery, thereby providing plausible mechanisms for prolonged clinical recovery.

Immunization and vitamin A supplementation were not significantly associated with hospitalization duration. This differs partly from the findings of Kasundriya et al., where incomplete immunization and lack of vitamin A supplementation were associated with severe pneumonia. [1] A community-based Indian study also found partial immunization to be associated with pneumonia occurrence. [13] These differences may reflect distinct outcomes: previous studies primarily examined pneumonia occurrence or severity, whereas the present analysis evaluated duration of hospitalization among children already admitted with CAP. Preventive interventions may substantially affect the probability of developing pneumonia or severe disease without necessarily determining length of stay after hospitalization.

Hand hygiene and toilet use were both significantly associated with lower odds of prolonged hospitalization. The findings suggest that household hygiene and sanitation may be markers of broader health-promoting environments rather than isolated determinants of pneumonia recovery. The community study by Gothankar et al. documented substantial deficiencies in maternal hand-hygiene knowledge and practices and examined these alongside other childhood pneumonia risk factors. [13] However, relatively few original studies have directly evaluated

household hand hygiene or toilet use specifically as predictors of *length of hospital stay* in childhood CAP. Therefore, these associations should be interpreted cautiously and would benefit from confirmation in larger prospective studies.

Environmental exposures

Cooking-fuel exposure and parental smoking were associated with numerically higher proportions of prolonged hospitalization, but neither reached statistical significance. These results are noteworthy because environmental smoke exposure is well established as a risk factor for childhood respiratory disease, although its relationship with hospitalization duration is less consistently demonstrated. Mahalanabis et al., in an Indian case-control study, reported that solid-fuel use was associated with substantially increased odds of childhood pneumonia. [14] A large nationally representative Indian study also demonstrated increased odds of acute respiratory infection among children exposed to biomass cooking fuel and household smoking. [15] Awasthi et al. further found biomass-fuel use to increase the odds of hypoxic CAP among hospitalized under-five children. [2]

Nevertheless, the absence of a significant association with prolonged hospitalization was not entirely inconsistent with previous Indian evidence. Gothankar et al. found no significant association between cooking-fuel type and reported childhood pneumonia in their community-based study. [13] Champatiray et al., in Odisha, also found smoke exposure comparable between severe and very severe pneumonia groups. [8] Thus, household smoke exposure may be more important for susceptibility to respiratory infection and development of severe or hypoxic disease than as a direct determinant of hospitalization duration once treatment has commenced.

Clinical manifestations

Among the clinical manifestations evaluated, grunting was significantly associated with prolonged hospitalization, with affected children having approximately 3.3-fold greater odds of staying beyond 7 days. Grunting is an indicator of increased respiratory effort and impaired pulmonary mechanics and can therefore represent more severe lower respiratory tract involvement. This result is compatible with the broader literature demonstrating that markers of respiratory compromise predict adverse pneumonia outcomes. In the recent CAP study by Alharbi et al., moderate-to-severe pneumonia was associated with almost tenfold higher adjusted odds of prolonged hospitalization,

while hypoxia and ventilatory support were considerably more frequent among children with extended stays. [10] Awasthi et al. similarly demonstrated that clinical indicators of severe physiological compromise—including tachypnea, pallor, low pulse volume, danger signs, and comorbidity—were associated with hypoxic CAP. [2]

Abdominal pain showed the largest observed association, with an OR of 11.526 for prolonged hospitalization. However, only seven children had abdominal pain, and the confidence interval was very wide (95% CI: 1.339–99.253). This indicates considerable statistical uncertainty around the magnitude of the association. Although abdominal symptoms can accompany lower-lobe pneumonia or more systemic illness, the small number of exposed children means that this result requires cautious interpretation and external validation before abdominal pain can be considered a reliable prognostic marker.

Fever, cough, rapid breathing, chest indrawing, vomiting, and chest pain were not significantly associated with prolonged hospitalization. Several of these manifestations are core diagnostic features of childhood pneumonia and may therefore be common across both shorter- and longer-stay groups, reducing their ability to discriminate prognosis. In the Odisha study by Champatiray et al., cough and tachypnea were present in all severe/very severe pneumonia cases and fever in 97.1%, illustrating the high prevalence of these manifestations among hospitalized patients. [8] Their diagnostic importance should therefore be distinguished from their prognostic utility.

Laboratory and physiological parameters

TLC showed a strong association with hospitalization duration. Children with TLC >15 had approximately fourfold higher odds of prolonged hospitalization than those with lower counts. Tiewsoh et al. reported that abnormal leukocyte counts were significantly associated with mortality in severe childhood pneumonia, although leukocyte abnormalities were not specifically identified as an independent determinant of prolonged hospitalization. [5] The present association is nevertheless clinically plausible because marked leukocytosis can reflect a greater systemic inflammatory response, bacterial infection, complications, or more severe disease. TLC should not, however, be interpreted in isolation because leukocyte responses vary with pathogen, age, disease stage, prior antibiotic exposure, and other clinical factors.

Hemoglobin level was also strongly associated with duration of hospitalization. Children with hemoglobin >10 had 75% lower odds of prolonged hospitalization than those

with hemoglobin ≤ 10 . This finding was closely aligned with Dinku et al., who identified anaemia as a significant predictor of prolonged hospitalization among children aged 2–59 months with severe CAP. [6] Tiewsoh et al. also demonstrated that pallor was strongly associated with mortality in severe pneumonia. [5] Similarly, Awasthi et al. identified pallor as a factor associated with hypoxic CAP in a large Indian multicentre population. [2] Anaemia may reduce oxygen-carrying capacity and compound the physiological consequences of impaired pulmonary gas exchange, particularly in severe pneumonia, providing a plausible explanation for slower clinical recovery.

Respiratory rate categorized at 55/min was not associated with prolonged hospitalization. This does not negate the established clinical importance of tachypnea in childhood pneumonia. Rather, a single dichotomous threshold may inadequately capture respiratory severity across an age range in which normal respiratory rate and WHO tachypnea thresholds vary with age. In addition, respiratory rate can be influenced by fever, agitation, hypoxemia, and timing of assessment.

Treatment and clinical outcome

Children receiving more than two antibiotics had a higher proportion of prolonged hospitalization than those receiving two or fewer antibiotics (50.0% vs. 34.7%), although the difference was not statistically significant. Tiewsoh et al. reported that 56.5% of children with severe pneumonia required a change in antibiotics and investigated antibiotic modification as an important morbidity outcome alongside prolonged hospitalization. [5] The direction of causality is particularly important when interpreting antibiotic number: administration of multiple antibiotics may be a consequence of severe, complicated, or poorly responsive pneumonia rather than a cause of prolonged hospitalization. Therefore, the number of antibiotics is better interpreted as a potential marker of treatment complexity or disease severity unless temporality and confounding are adequately addressed.

Clinical outcome was strongly associated with length of stay. Children who were cured had significantly lower odds of prolonged hospitalization compared with those shifted to the ICU. This is consistent with evidence that greater disease severity and need for advanced respiratory or intensive care are associated with extended hospitalization. Alharbi et al. found that moderate-to-severe pneumonia, complications, hypoxia, and ventilatory support were substantially more frequent among children experiencing prolonged hospitalization. [10] Similarly, Champatiray et al. reported greater mortality among children with very severe

pneumonia and a longer mean hospital stay in the very severe group. [8]

The association between ICU transfer and prolonged stay should nevertheless be interpreted primarily as an indicator of disease course rather than a baseline predictor because transfer to the ICU may occur after admission and may itself extend hospitalization. Consequently, clinical outcome and ICU transfer are conceptually different from admission-level prognostic factors such as nutritional status, haemoglobin, or presenting respiratory signs.

Adverse drug reactions

ADR occurrence was not associated with prolonged hospitalization. The proportion staying >7 days was nearly identical among children with and without ADRs (37.8% vs. 37.0%), with an OR close to unity. This suggests that, within this cohort, recorded ADRs did not materially influence overall length of hospitalization. The effect of ADRs on hospitalization can depend strongly on their severity, preventability, implicated drug, timing of onset, and whether they necessitate treatment modification. Since the present analysis categorized ADR status simply as present or absent, a potential effect of severe or treatment-limiting ADRs could have been diluted by more minor reactions. Research specifically examining ADR occurrence as a determinant of hospitalization duration in under-five CAP is limited, making this finding an area for further study rather than one permitting strong comparison with established CAP literature.

Generalisability

The findings of this study are primarily generalisable to under-five children with pneumonia receiving inpatient care in tertiary-care hospitals with comparable patient profiles, treatment practices, and healthcare settings. As the study was conducted in a single tertiary-care institution and included hospitalised children, the participants may have represented relatively more severe or complicated cases than those managed in primary care, secondary-care facilities, or outpatient settings. Therefore, the observed patterns of drug utilisation, adverse drug reactions, treatment outcomes, and factors associated with prolonged hospital stay may not be directly applicable to all children with community-acquired pneumonia in the general population.

Generalisability is further limited by the single-centre, cross-sectional observational design and relatively modest sample size, which may restrict representation of variations in prescribing practices, antimicrobial resistance patterns, socioeconomic conditions, referral practices, and clinical

management across different regions and institutions. Nevertheless, because the study reflects routine clinical practice in a tertiary-care hospital and includes commonly encountered demographic, nutritional, clinical, therapeutic, and safety-related variables, the findings may be reasonably applicable to similar tertiary-care settings in eastern India and other resource-comparable regions. Multicentre prospective studies involving larger and more geographically diverse populations would be required to improve the external validity of these findings.

Conclusion

Prolonged hospitalization among under-five children with community-acquired pneumonia was associated with a complex interplay of socioeconomic disadvantage, household conditions, nutritional vulnerability, clinical severity, and laboratory abnormalities. Lower family income, larger household size, absence of breastfeeding, malnutrition, poor hygiene and sanitation practices, grunting, elevated leukocyte count, and lower hemoglobin emerged as important correlates of longer hospital stay. These findings emphasize that the course of childhood pneumonia extends beyond the infection itself and is influenced by both modifiable social determinants and measurable clinical factors. Early recognition of these high-risk characteristics at admission, coupled with nutritional support, correction of anemia, appropriate clinical monitoring, and strengthened preventive and household health practices, may help optimize care and reduce the burden of prolonged hospitalization.

Limitations

The study had several limitations. First, its single-centre, cross-sectional observational design limited the ability to establish temporal or causal relationships between the identified factors and prolonged hospitalization and may restrict generalisability to other healthcare settings. Second, the relatively small sample size ($n = 118$) reduced statistical power, particularly for infrequent characteristics such as abdominal pain, as reflected by the wide confidence interval around its odds ratio. Third, the analysis was primarily bivariable, and therefore the observed associations represented unadjusted effects; potential confounding and interactions among socioeconomic, nutritional, clinical, and laboratory factors could not be excluded. Fourth, some potentially relevant determinants of hospital stay, including etiological pathogens, microbiological findings, radiological severity, antimicrobial resistance patterns, oxygen requirement, comorbidities, and detailed pneumonia

severity measures, were not incorporated into the present analysis.

Recommendations

Based on the findings of this study, the following measures are recommended to reduce the risk and burden of prolonged hospitalization among under-five children with community-acquired pneumonia:

1. **Early risk stratification at admission** should incorporate socioeconomic, nutritional, clinical, and laboratory characteristics associated with prolonged hospitalization, particularly household crowding, malnutrition, grunting, anemia, and elevated total leukocyte count.
2. **Nutritional assessment should be integrated into routine pneumonia management**, with early identification and appropriate management of malnutrition. Promotion of breastfeeding should remain an important component of preventive child-health interventions.
3. **Hemoglobin and leukocyte abnormalities should receive appropriate clinical attention**, particularly when accompanied by signs of severe respiratory illness, as these children may require closer monitoring and more intensive supportive management.
4. **Children presenting with markers of greater clinical severity**, particularly grunting or requiring escalation to intensive care, should be closely monitored for complications and delayed recovery to facilitate timely intervention.
5. **Household-level preventive measures** should be strengthened through caregiver education regarding hand hygiene, sanitation, appropriate toilet use, breastfeeding, nutrition, and early healthcare seeking for symptoms of pneumonia.
6. **Antibiotic stewardship should be emphasized**, with antimicrobial therapy guided by clinical indication, institutional protocols, and microbiological evidence whenever available, rather than unnecessary escalation or use of multiple antibiotics.
7. **Active pharmacovigilance should continue during hospitalization** to ensure early detection, assessment, documentation, and appropriate management of adverse drug reactions, even though ADR occurrence was not significantly associated with prolonged hospital stay in this study.

8. Future research should employ **larger, multicentre prospective designs with multivariable analysis** to identify independent predictors of prolonged hospitalization. Incorporating pneumonia severity, radiological findings, microbiological etiology, antimicrobial susceptibility, oxygen requirement, comorbidities, and treatment response would further improve risk prediction and clinical applicability.

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Conflict of Interest

The authors declare that they have **no conflicts of interest** relevant to this study.

Consent for Publication

No personally identifiable information of the study participants has been presented in the manuscript. Where required by the target journal, consent for publication was obtained from the parent or legally authorized representative.

Data Availability Statement

The data generated and analyzed during the study are available from the **corresponding author on reasonable request**, subject to institutional and ethical requirements governing participant confidentiality and data sharing.

Abbreviations

ADR: Adverse Drug Reaction; **CAP:** Community-Acquired Pneumonia; **CI:** Confidence Interval; **ICU:** Intensive Care Unit; **IEC:** Institutional Ethics Committee; **OR:** Odds Ratio; **TLC:** Total Leukocyte Count; **SPSS:** Statistical Package for the Social Sciences.

Author Contributions

Dr. Snehasini Dash: Conceptualization, methodology, investigation, data curation, and writing – original draft.

Dr. Suwendu Kumar Panda: Conceptualization, methodology, statistical analysis, validation, interpretation of results, writing – review & editing, supervision, and correspondence.

Dr. Dhurjati Prasad Mahapatra: Clinical validation, investigation, interpretation of clinical findings, and writing – review & editing.

Dr. Pragnya Padhy: Investigation, data curation, literature review, and writing – review & editing.

Dr. Soubhagya Mayee Sahoo: Investigation, data curation, literature review, and writing – review & editing.

Dr. Srikanta Panigrahy: Investigation, data curation, validation, and writing – review & editing.

All authors reviewed and approved the final manuscript.

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