Original article

Predictors of Prolonged Hospital Stay in Children Admitted with Community-Acquired Pneumonia: A Prospective Observational Study

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Date of final acceptance – 04 September 2018, Date of publication- 18 December 2018

Abstract

Background: Community-acquired pneumonia (CAP) remains an important cause of hospitalization among children, particularly in low- and middle-income countries. Although most hospitalized children improve within a few days, a subgroup requires prolonged hospitalization, resulting in increased healthcare utilization, treatment costs, and risk of hospital-associated complications. Identification of clinical predictors of prolonged hospital stay may facilitate early risk stratification.

Objectives: To determine the clinical, laboratory, and radiological factors associated with prolonged hospital stay among children admitted with CAP.

Materials and Methods: This prospective observational study included 40 children aged 2 months to 12 years admitted with CAP over a period of six months. Demographic characteristics, nutritional status, presenting symptoms, oxygen saturation, severity indicators, laboratory parameters, radiological findings, treatment requirements, complications, and duration of hospitalization were recorded. Prolonged hospital stay was defined as hospitalization for >7 days. Children were categorized into normal-stay (≤7 days) and prolonged-stay (>7 days) groups. Predictors were assessed using appropriate statistical tests and logistic regression.

Results: Of 40 children, 13 (32.5%) had prolonged hospitalization. Hypoxemia at admission, severe pneumonia, malnutrition, elevated C-reactive protein (CRP), pleural effusion/complicated pneumonia, and requirement for respiratory support were significantly more frequent among children with prolonged stay. On multivariable analysis, admission hypoxemia, severe pneumonia, and pneumonia-related complications emerged as the strongest predictors of prolonged hospitalization.

Conclusion: Hypoxemia, greater disease severity, malnutrition, elevated inflammatory markers, and pulmonary complications are important indicators of prolonged hospitalization in pediatric CAP. Early recognition of these factors may facilitate appropriate monitoring and resource allocation.

Keywords: Community-acquired pneumonia, children, hospital stay, hypoxemia, malnutrition, pneumonia severity, predictors.

Introduction

Community-acquired pneumonia (CAP) is one of the most important infectious diseases affecting children and remains a major contributor to childhood morbidity, hospitalization, and mortality worldwide. Despite improvements in vaccination, antimicrobial therapy, nutrition, and supportive care, pneumonia continues to impose a substantial burden, particularly in low- and middle-income countries [1,2]. Children requiring hospitalization demonstrate considerable variation in clinical severity and duration of hospital stay.

The length of hospitalization is influenced by host characteristics, disease severity, underlying comorbidities, complications, and response to treatment. Hypoxemia is particularly important because it indicates impaired

pulmonary gas exchange and is associated with adverse outcomes [2,3]. Other reported risk factors for severe or prolonged disease include younger age, malnutrition, anemia, delayed presentation, elevated inflammatory markers, underlying illness, pleural effusion, and requirement for respiratory support [4-7].

Prolonged hospitalization increases healthcare expenditure, occupies limited pediatric beds, increases caregiver burden, and may expose children to healthcare-associated complications. Identification of predictors available at or shortly after admission could therefore help clinicians recognize high-risk children and optimize management. The present study was undertaken to evaluate predictors of prolonged hospital stay among children admitted with CAP at a tertiary care hospital.

Materials and Methods

A **prospective observational study** was conducted in the Department of Pediatrics of a tertiary care teaching hospital over a period of **six months**. Children admitted with a clinical diagnosis of community-acquired pneumonia during the study period were screened for eligibility.

A total of **40 consecutive children** satisfying the inclusion and exclusion criteria were enrolled. The study population consisted of children aged **2 months to 12 years** admitted with CAP.

Inclusion Criteria

Children aged 2 months to 12 years with community-acquired pneumonia requiring hospital admission were included. CAP was diagnosed on the basis of acute respiratory symptoms such as cough and/or difficulty in breathing accompanied by clinical evidence of lower respiratory tract involvement, with radiological confirmation where clinically indicated.

Exclusion Criteria

Children developing pneumonia ≥48 hours after hospital admission, children with known hospital-acquired or ventilator-associated pneumonia, those recently hospitalized with ongoing nosocomial infection, children whose parents or guardians declined consent, and patients with incomplete clinical information were excluded.

After obtaining informed consent from the parent or legal guardian, demographic and clinical information was recorded using a predefined case-record form. Variables included age, sex, duration of symptoms before admission, fever, cough, difficulty in breathing, feeding difficulty, respiratory rate, chest retractions, oxygen saturation (SpO_2), nutritional status, and presence of associated medical conditions.

Pulse oximetry was performed at admission before oxygen supplementation whenever clinically feasible. Hypoxemia was defined as **SpO_2 <92% in room air** for the purpose of the study. Disease severity was classified using clinical findings, including respiratory distress, hypoxemia, danger signs, and requirement for respiratory or hemodynamic support.

Laboratory investigations were performed according to clinical indications and included complete blood count and C-reactive protein. Chest radiography was evaluated for consolidation, bilateral/multifocal involvement, pleural effusion, or other complications.

Treatment-related variables included intravenous antibiotic requirement, supplemental oxygen, non-invasive or invasive respiratory support, intravenous fluids, change/escalation of antibiotic therapy, and development of complications.

Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, depending upon distribution. Categorical variables were presented as frequencies and percentages.

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Results

A total of **40 children** with CAP were enrolled. The mean age was **3.6 ± 2.8 years**, and 23 (57.5%) were boys. The mean duration of hospitalization was **6.5 ± 3.1 days**. Twenty-seven children (67.5%) were discharged within seven days, whereas **13 children (32.5%) had prolonged hospitalization (>7 days).**

Table 1. Baseline Characteristics of the Study Population

Characteristic	Total (n=40)	Hospital stay ≤7 days (n=27)	Hospital stay >7 days (n=13)	p-value
Mean age, years	3.6 ± 2.8	3.9 ± 2.9	3.0 ± 2.5	0.34
Age <1 year	9 (22.5%)	4 (14.8%)	5 (38.5%)	0.12
Male sex	23 (57.5%)	16 (59.3%)	7 (53.8%)	0.74
Symptoms >5 days before admission	15 (37.5%)	7 (25.9%)	8 (61.5%)	0.03*
Malnutrition	14 (35.0%)	6 (22.2%)	8 (61.5%)	0.015*
Associated comorbidity	8 (20.0%)	3 (11.1%)	5 (38.5%)	0.047*
Mean hospital stay, days	6.5 ± 3.1	4.8 ± 1.3	10.1 ± 2.4	<0.001*

*Statistically significant.

Children with prolonged hospitalization more frequently had delayed presentation, malnutrition, and associated comorbidity. Age and sex were not significantly associated with prolonged stay.

Table 2. Clinical, Laboratory and Radiological Factors Associated with Prolonged Hospital Stay

Parameter	Stay ≤7 days (n=27)	Stay >7 days (n=13)	p-value
Severe pneumonia	6 (22.2%)	10 (76.9%)	0.001*
SpO_2 <92% at admission	5 (18.5%)	9 (69.2%)	0.002*
Marked chest retractions	7 (25.9%)	9 (69.2%)	0.009*
Feeding difficulty	6 (22.2%)	8 (61.5%)	0.015*
Hemoglobin <10 g/dL	7 (25.9%)	7 (53.8%)	0.08
Leukocytosis	10 (37.0%)	8 (61.5%)	0.15
CRP >40 mg/L	7 (25.9%)	9 (69.2%)	0.009*
Multilobar/bilateral involvement	5 (18.5%)	7 (53.8%)	0.023*
Pleural effusion/complication	1 (3.7%)	5 (38.5%)	0.007*

*Statistically significant.

Hypoxemia was present in 14 (35%) children overall and was substantially more frequent in the prolonged-stay group. Severe pneumonia, marked retractions, feeding difficulty, elevated CRP, multilobar disease, and pleural complications were also significantly associated with hospitalization exceeding seven days.

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Table 3. Treatment Factors and Predictors of Prolonged Hospitalization

Factor	Stay ≤7 days (n=27)	Stay >7 days (n=13)	Approx. OR (95% CI)	p-value
Oxygen supplementation	7 (25.9%)	10 (76.9%)	9.5 (2.0–44.8)	0.003*
Respiratory support beyond low-flow oxygen	1 (3.7%)	5 (38.5%)	16.3 (1.6–161.5)	0.007*
Antibiotic escalation/change	5 (18.5%)	8 (61.5%)	7.0 (1.6–31.3)	0.007*
Pneumonia-related complication	1 (3.7%)	5 (38.5%)	16.3 (1.6–161.5)	0.007*
Admission hypoxemia	5 (18.5%)	9 (69.2%)	9.9 (2.1–46.4)	0.002*
Severe pneumonia	6 (22.2%)	10 (76.9%)	11.7 (2.4–56.7)	0.001*

*Statistically significant.

On regression assessment, **severe pneumonia, admission hypoxemia, and pneumonia-related complications** showed the strongest association with prolonged hospitalization. Because of the small sample size and wide confidence intervals, these estimates should be interpreted cautiously.

Discussion

The present study evaluated predictors of prolonged hospitalization among 40 children admitted with community-acquired pneumonia. Approximately one-third (32.5%) required hospitalization for more than seven days. The principal factors associated with prolonged stay were severe pneumonia, hypoxemia at admission, malnutrition, delayed presentation, elevated CRP, multilobar disease, pleural complications, and requirement for respiratory support.

Hypoxemia was one of the most important findings. Nearly 69% of children with prolonged stay had an admission SpO_2 below 92%, compared with 18.5% of those discharged within seven days. Oxygenation is a central component of pediatric pneumonia severity assessment. Pediatric CAP guidance emphasizes respiratory distress and hypoxemia when determining the need for inpatient and higher-level care [1,2]. WHO guidance similarly recognizes hypoxemia as an important marker of severe respiratory disease [3].

The present findings are supported by studies from resource-limited settings. Ramachandran et al. observed that oxygen saturation below 90% at presentation was associated with prolonged hospitalization in children with severe pneumonia [4]. Similarly, an Indian multicentric prospective cohort demonstrated that SpO_2 <92% was strongly associated with hospitalization among children with pneumonia [5]. Hypoxemia represents more extensive impairment of pulmonary gas exchange and is therefore likely to reflect greater disease burden and slower clinical recovery.

Disease severity was another strong predictor. More than three-fourths of children in the prolonged-stay group had severe pneumonia compared with approximately one-fifth in the normal-stay group. This finding is biologically expected because severe disease frequently requires prolonged oxygen supplementation, intravenous treatment, closer monitoring, and respiratory support. Williams et al. demonstrated that hypoxia, increased work of breathing, and comorbidities were associated with moderate-to-severe pediatric pneumonia outcomes [6].

A recent study by Alharbi et al. specifically evaluated prolonged hospitalization among children with CAP and reported that moderate-to-severe pneumonia, pneumonia-related complications, and underlying chronic conditions independently predicted prolonged hospitalization [7]. These observations closely support the pattern

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seen in our study. The same study found hypoxia and ventilatory support to be substantially more common among children with prolonged hospitalization, although they did not remain independent predictors in the final model [7].

Malnutrition was significantly associated with prolonged stay in our population. Sixty-one percent of children with prolonged hospitalization were malnourished compared with 22.2% of children with shorter hospitalization. Malnutrition can impair innate and adaptive immunity, compromise respiratory muscle function, and delay recovery from infection. An Indian study reported strong associations between malnutrition, anemia, and hypoxia among hospitalized children with CAP [8]. In a large northern Indian cohort, severe malnutrition was also associated with hypoxic pneumonia [9]. More recent evidence from Angola has identified malnutrition as an independent risk factor for prolonged hospitalization among pediatric CAP patients [10].

Delayed presentation was also significantly associated with prolonged stay. Children presenting after more than five days of symptoms may have greater inflammatory burden or already established complications. A study from Ethiopia similarly identified late presentation, wasting, anemia, and pulmonary effusion among factors predicting prolonged hospitalization in severe CAP [11]. These observations highlight the importance of early recognition and timely referral of children with worsening respiratory symptoms.

Elevated CRP was significantly more frequent among children requiring prolonged hospitalization. Although CRP should not be interpreted as a stand-alone marker of bacterial etiology or severity, it can provide useful supplementary information in hospitalized children when considered alongside clinical findings. Studies in pediatric CAP have demonstrated an association between increasing CRP concentrations and longer hospital stay [12]. In our study, CRP >40 mg/L was observed in 69.2% of the prolonged-stay group compared with 25.9% of the normal-stay group.

Radiological extent of disease also influenced hospitalization. Multilobar or bilateral involvement was more common in children with prolonged stay, while pleural effusion or another pneumonia-related complication demonstrated an especially strong association. Complicated pneumonia frequently requires prolonged intravenous antimicrobial therapy, drainage procedures, serial imaging, and extended observation. Breuer et al. similarly demonstrated that children with complicated pneumonia can have highly variable but frequently prolonged clinical courses [13].

Although anemia was more frequent among children with prolonged hospitalization, the difference did not reach statistical significance in our small sample. This may reflect inadequate statistical power rather than absence of a biological relationship. Larger studies have demonstrated relationships between anemia, malnutrition, hypoxia, and adverse pneumonia outcomes [8,11].

Requirement for oxygen supplementation, respiratory support, and escalation of antibiotics was substantially greater among children with prolonged stay. These variables are partly consequences of greater disease severity rather than purely baseline predictors. Nevertheless, their early occurrence during hospitalization can identify children likely to require longer inpatient care.

The findings have practical clinical relevance. Simple parameters such as pulse oximetry, nutritional assessment, feeding ability, respiratory effort, and chest radiographic complications are readily obtainable in most pediatric units. Their combined assessment can identify children who may need closer monitoring, earlier senior review, aggressive supportive care, and counseling of caregivers regarding the probable duration of hospitalization.

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Conclusion

Prolonged hospital stay occurred in approximately one-third of children admitted with community-acquired pneumonia in this study. Admission hypoxemia, severe pneumonia, malnutrition, elevated CRP, multilobar radiological involvement, pneumonia-related complications, and requirement for respiratory support were significantly associated with prolonged hospitalization. Severe pneumonia, hypoxemia, and pulmonary complications demonstrated the strongest associations.

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