RESEARCH ARTICLE

Factors correlate with prolonged hospitalization in pediatric pneumonia: A retrospective analysis

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Background: Community Acquired Pneumonia (CAP) is a common cause of pediatric hospitalization and remains a significant contributor to morbidity and healthcare burden globally. Prolonged hospital stays can complicate outcomes and strain healthcare systems. Identifying predictors of hospital stay duration may inform clinical decision-making and optimize care. This study aims to investigate clinical and biochemical factors correlate with the duration of hospitalization among pediatric patients with pneumonia.

Methods: A retrospective study conducted at a tertiary pediatric hospital Baghdad Iraq, over 6-months period on pediatric patients aged 2 months to <15 years diagnosed with CAP. Data collected included demographics, Clinical signs including vital signs at admission, and peripheral oxygen saturation (Spo2), duration of dyspnea, and time to defervescence. Laboratory parameters: white blood cell (WBC) count, absolute lymphocyte count, absolute neutrophil count, C-reactive protein (CRP) level, serum potassium, and serum sodium concentrations.

Results: A total of 240 child diagnosed with pneumonia were included. The average hospital stay were 7 ± 4.99 days with 142 (59.2%) had more than 7 days of hospitalization. Those had significantly higher mean respiratory rates, heart rate and body temperature and lower oxygen saturation levels. In addition, laboratory tests in children with prolonged hospitalization showed significantly higher WBC counts, neutrophil counts, and CRP levels with P-value (<0.001, 0.005, and <0.001 respectively). On logistic regression, three independent predictors were significantly associated with increased odds for prolonged hospital stay including elevated body temperature (OR= 6.194, 95% CI: 2.108 -18.199; P= 0.001), and lower oxygen saturation at time of admission (OR=0.783, 95% CI: 0.616-0.994; P=0.045) and heart rate (OR=0.947,95% CI: 0.906 -0.990; P= 0.017).

Conclusion: clinical signs at time of admission indicative of severe pneumonia -namely tachycardia, elevated body temperature, and hypoxia can be used to predict prolonged hospitalization in pediatric patients diagnosed with pneumonia.

Keywords: C-reactive protein, hospital stay, pneumonia, pediatrics

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Introduction

Community acquired pneumonia (CAP) is defined as the presence of cough or difficulty breathing accompanied by age specific tachypnea outside hospital setting or within 48 hours of hospital admission [1]. It represents a leading cause of morbidity and mortality in children globally with varied worldwide incidence [2]. Although timely management is achieved in many children, a subset may develop complications or severe course requiring prolonged hospitalization. Identifying clinical and laboratory factors associated with prolonged hospital stay is critical for pediatricians to improve triage, monitoring, and management strategies [3,4].

The average duration of hospital stays for children admitted with CAP varies across countries. For instance, two studies from Ethiopia reported a median stay of 5 days [5,6]. Moreover, a systematic review noted an average stay of 5.8 days in low income and 7.7 days in high income countries [7]. In Iraq, however, published data regarding duration of hospitalization in CAP is very limited with previous studies mainly focus on factors related to severity of pneumonia [8]. While previous studies highlighted few factors associated with severity and outcomes of pneumonia in children, including hypoxia and malnutrition, few have focused on predictors of hospitalization duration in pediatric settings [9,10] .

Prolonged hospital stay imposes significant burdens on the healthcare system. It is associated with an increased risk of an adverse drug reactions, hospital acquired infections, and hospital acquired malnutrition [11,12]. Moreover, extended hospitalization in children particularly in the context of infectious diseases like CAP has negative psychological implications, including a higher risk of anxiety, depressive symptoms, and impaired social coping skills [13–15].

The value of recognizing factors associated with prolonged hospital stay in a very common infectious disease like pneumonia cannot be overemphasized. This especially true in low resources countries including Iraq. This study aims to investigate the correlation between duration of hospital stay and various clinical and biochemical parameters in children with pneumonia admitted to a tertiary care hospital.

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Methods

Study design and participants

A retrospective study was conducted at Central Pediatric Teaching Hospital, a tertiary pediatric hospital Baghdad Iraq, over 6-months period from 1st of January 2025 to July 1st, 2025. Data were collected from medical records of children admitted with primary diagnosis of community acquired pneumonia, based on clinical signs and symptoms and chest radiographs. Inclusion criteria were age 2 months to <15 years, confirmed pneumonia by chest radiographs, complete medical records including clinical, laboratory, and hospitalization data. Exclusion criteria: age less than 2 months, known chronic pulmonary and congenital heart disease, those with incomplete or missing data. All children diagnosed with community acquired pneumonia during study period were eligible for the study after matching the inclusion criteria.

Data collection

The following variables were extracted from patients' medical records:

Demographical data: age (in months), sex, place of residence.

Clinical data: vital signs at admission, including heart rate, respiratory rate, body temperature, and peripheral oxygen saturation (Spo2); type and requirement of supplemental oxygen, duration of dyspnea, and time to defervescence.

Laboratory parameters: white blood cell (WBC) count, absolute lymphocyte count, absolute neutrophil count, C-reactive protein (CRP) level, serum potassium, and serum sodium concentrations.

Outcome measure: length of hospital stays (LOS), recorded in days.

According to the mean of hospital stay observed in the study cohort (7.0 ± 4.99), patients were stratified into two groups: those with prolonged hospital stay (LOS > 7 days) and those without prolonged stay (LOS ≤ 7days).

Sample size estimation: sample size calculation was based on the following formula [16]:

$$n=\frac{Z^2 P\,(1-P)}{E^2}$$

Z = 1.96 for 95% confidence, P= derived from previous studies =30% [17] , and the desired margin of error =5%. So, the estimated sample size is 240

Statistics

Statistical analysis was conducted using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive data were used to summarize demographic and clinical profile of the study population, with continuous variables summarized as means ± standard deviations (SD), and categorical variables expressed as frequencies and percentages. The independent samples t-test was employed to compare means between groups, while associations between categorical variables and length of hospital stay (LOS) were assessed using the Chi-square test. A P-value < 0.05 deemed statistically significant. To identify independent predictors for prolonged hospital stay (LOS>7 days) in children with pneumonia, relevant factors showed significant association with prolonged hospital stay on univariate analysis were analyzed by logistic regression.

Ethical approval

The ethical committee at Mustansiriyah University -college of medicine approved the study with IRB 100 dated on 9-9-2024

Results

A total of 240 child diagnosed with pneumonia were included. The mean age was 23.82 ± 19.89 months with 47% were infants and 50.8% of male gender. The average hospital stay were 7 ± 4.99 days with majority 59.2% had more than 7 days of hospitalization and 88.5% of urban residence, Table 1.

None of the demographical characteristic showed significant association with length of hospital stay, Table 2.

Patients with prolonged LOS (>7 days) had significantly higher mean respiratory rates (65.04 ± 14.44 vs. 57.87±13.47 breaths/min, P-value= 0.007), heart rate (130.08±18.12 vs. 123.45 ± 13.57 bpm, P-value= 0.032) and body temperature (38.76±1.15°C vs. 37.94 ± 0.69°C, p<0.001) compared to those with a shorter LOS (≤7 days). Additionally, these patients had significantly lower oxygen saturation levels (87.17 ± 11.13% vs. 95.93 ± 2.94%, p < 0.001). Furthermore, the duration of dyspnea prior to admission was markedly longer in the prolonged LOS group (6.31± 2.45 vs. 2.96±1.04 days, p < 0.001), as was the time to defervescence (3.69 ± 2.28 vs. 1.42 ± 0.50 days, p < 0.001), Table 3.

Children with pneumonia hospitalized for more than 7 days showed significantly higher WBC counts, neutrophil counts, and CRP levels with P-value (<0.001, 0.005, and <0.001 respectively). The lymphocyte counts were significantly lower in children with long hospital stay P-value (0.004). Regarding serum electrolytes, serum sodium was lower in children with high hospital stay P-value (<0.001), while serum potassium showed insignificant difference P-value (0.103), Table 4.

On multivariable logistic regression analysis, higher body temperature at admission was independently associated with increased odds of prolonged hospital stay, with adjusted odds ratio of 6.194 (95% CI: 2.108-18.199; P=0.001). In contrast, increased odds for prolonged hospital stay were associated with lower oxygen saturation (OR=0.783, 95% CI: 0.616-0.994; P=0.045) and lower heart rate (OR=0.947,95% CI: 0.906-0.990; P=0.017). Serum sodium level was not statistically significant but demonstrated a potential association with prolonged hospital stay (OR= 0.874; 95% CI: 0.751–1.016; P= 0.079), Table 5.

Table 1. Clinical and Demographical characteristics of the study group

Variables	Values
Age, months	
Mean ± SD	23.82 ± 19.89
Infant (below 12 months)	114(47.5%)
Toddler (12 m to <24 months)	38(15.8%)
Preschoolers (24-59 months)	58(24.2%)
School age (60 to 119 months)	24(10.0%)
Older children and adolescent (120 months and more)	6(2.5%)
Gender, n (%)	
Male	122 (50.8%)
Female	118 (49.2%)
Residence, n (%)	
Urban	212(88.5%)
Rural	28 (11.5%)
Length of hospital stay (LOS), days.	
Mean ± SD	7.0 ± 4.99
LOS ≤ 7days	98 (40.8%)
LOS > 7 days	142 (59.2%)

Table 2. Association of patient's demographics and length of hospital stay

Variables		LOS ≤ 7days n= 98	LOS > 7 days n= 142	P -value
Age				
	Infant	54(55.1%)	60(42.3%)	
	Toddler	18(18.4%)	20(14.1%)	0.238
	Preschoolers	16(16.3%)	42(29.6%)	
	School age	10(10.2%)	14(9.9 %)	
	Older children and adolescent	0(0%)	6(4.2%)	
Sex				
	Male	50 (51%)	72 (50.7%)	0.973
	Female	48 (49%)	70 (49.3%)	
Residence				
	Urban	84 (85.7%)	128 (90.1%)	0.981
	Rural	14 (14.3%)	14 (9.9%)	

Table 3. distribution of symptoms and signs of patients by length of hospital stay

Variables	LOS ≤ 7days (Mean ± SD)	LOS > 7 days (Mean ± SD)	P -value
Respiratory rate, (breaths/minute)	57.87± 13.47	65.04 ± 14.44	0.007
Heart rate, (beats/min)	123.45±13.57	130.08±18.12	0.032
Temperature, (°C)	37.94± 0.69	38.76±1.15	<0.001
Oxygen saturation, (SpO2, %)	95.93± 2.94	87.17±11.13	<0.001
Duration of dyspnea, (days)	2.96 ±1.04	6.31 ±2.45	<0.001
Time to defervescence, (days)	1.42 ±0.50	3.69 ±2.28	<0.001

Table 4. Distribution of assessed laboratory parameters by length of stay in hospital (LOS)

variables	LOS ≤ 7days (Mean ± SD)	LOS > 7 days (Mean ± SD)	P -value
Total WBC count	17.14±4.17	22.11±8.22	<0.001
Neutrophil	12.27±8.82	18.27±8.82	0.005
Lymphocyte	4.99±2.04	3.84±2.28	0.004
Serum sodium	132.78±4.06	126.44±5.72	<0.001
Serum potassium	4.69±1.32	3.64±0.57	0.103
C-reactive protein	37.04±30.54	87.83±56.71	<0.001

Table 5. Results of binary regression analysis for the predictors of prolonged LOS in children with pneumonia

Variables	B	S.E.	OR	95% C.I. for OR	P -value
Heart rate (HR)	-0.054	0.023	0.947	0.906-0.990	0.017
Body temperature (Temp)	1.824	0.550	6.194	2.108-18.199	0.001
Oxygen saturation (SPO2)	-0.245	0.122	0.783	0.616-0.994	0.045
Serum Sodium concentration (S. Na)	-0.135	0.077	0.874	0.751-1.016	0.079

Discussion

This study aimed to identify predictors for prolonged hospital stay among children diagnosed with pneumonia. Data demonstrated that majority 142 (59.2%) had more than 7 days of hospitalization and those had significantly higher mean respiratory rates, heart rate and body temperature and lower oxygen saturation levels. In addition, laboratory parameters in children with prolonged LOS showed

significantly higher WBC counts, neutrophil counts, and CRP levels with P-value (<0.001, 0.005, and <0.001 respectively). On logistic regression, three independent predictors were significantly associated with increased odds for prolonged hospital stay including elevated body temperature, and lower oxygen saturation and lower heart rate at time of admission.

Pneumonia is a leading cause of hospitalization in pediatric age group with prolonged hospitalization carry several clinical, economic, and health care system implications [7,18]. The term prolonged hospitalization is not clearly defined in literature, with previous studies used mean or median length of hospital stay (LOS) as cutoff [5]. A few studies define it using percentile cutoff, such as 75th or 90th percentile of LOS [19,20] ,while others often consider LOS >7 days as prolonged [18,21]. In the current study, the mean of LOS were used as cutoff above which hospitalization was considered prolonged. Interestingly majority (59.2%) of admitted children with pneumonia in the present study required prolonged hospitalization which is higher than previously reported [22]. Dinku et al.[5] reported that only (28.9%) of required prolonged hospitalization in Ethiopia. This could be attributed to differences in threshold used for defining prolog hospitalization in the current study (>7 days) compared to Dinku et al (>5 days) this higher threshold results in higher proportion classified as prolonged stay in the current study.

The duration of hospitalization in children with pneumonia did not show statistically significant differences with the demographical characteristics including age, sex, and area of residence. With exception of sex which yield inconsistent results, young age and rural residence were linked to prolonged hospitalization in literature [19,23]. The young age of the children was strongly associated with prolonged hospital stay in a study by Basnet et al in Nepalese children hospitalized with pneumonia [24]. The effect of gender on length of hospitalization is extensively studied, with variety of studies demonstrated that female usually had delayed admission and thereby increase length of hospitalization in children with pneumonia [25]. others found a direct association between male gender and prolonged hospital stay [17]. However, in the present study, gender was not significantly affecting the LOS.

Our findings demonstrated that metabolic and inflammatory parameters at the time of admission significantly correlate with the length of hospital stay in children with pneumonia. These findings are aligned with previous studies that demonstrated higher systemic inflammatory response reflected by elevated inflammatory markers including CRP, WBC, ANC associated with disease severity [27–28]. Hyponatremia in children with pneumonia was linked to higher severity and worse outcomes[26]. The mechanism behind that is not completely understood but hyponatremia linked to syndrome of inappropriate antidiuretic hormone secretion that resulted from exaggerated inflammatory response with resultant higher levels of inflammatory mediators including interleukin 6 [27].

Despite that these biomarkers had limited predictive value for disease severity. In the present study, children with longer LOS (>7 days) demonstrated clinical sign of severe disease on admission as seen by lower oxygen saturation and heart rate with higher body temperature, respiratory rate, and longer time for defervescence and duration of dyspnea. These findings align with results of previous studies that demonstrated an association between higher systemic inflammatory response reflected by disturbed vital signs and hypoxemia with prolonged clinical course[28]. Severe pneumonia had been defined by the world health organization as the presence of a danger signs including hypoxia, cyanosis, chest indrawing, fast breathing together with signs of systemic toxicity in children with pneumonia[29,30]. These children had been proposed to require prolog hospitalization with multifactorial etiology. The higher incidence of complication, delayed response to antibiotics together with high bacterial load contribute to extending hospital stay[31].

In the current study, the clinical signs of severe disease were significant predictive for prolonged hospital stay with fever carry the highest odds for prolonged hospitalization 6.194 (95% CI: 2.108 -18.199; P= 0.001), in addition hypoxia was associated with higher odds for prolonged hospitalization. Moreover, hyponatremia show a trend for predicting prolonged hospital stay.

The identification of these predictors for prolonged hospitalization in this population of children play a critical role in mitigating the economic burden of prolonged hospitalizations mostly for low- and middle-income population [17]. The prolong hospital stay can directly increase medical cost including extended in patients' services, medication use and laboratory investigations. Therefore, by identifying predictors for prolonged hospitalization, health care providers can triage patients more effectively, initiate timely interventions which subsequently reduce incidence of complications that extend the duration of hospitalization[32].

The authors acknowledge several limitations of the present study including the small sample size, single center settings, and the retrospective design. Moreover, certain variables previously reported to correlate with prolonged hospitalization were not analyzed in the current study including the nutritional status and the family socioeconomic background. Future prospective studies with larger cohorts are recommended to validate the current predictors and to explore additional protentional predictors.

Conclusion

Approximately two-thirds of pediatric patients hospitalized with pneumonia required prolonged hospitalization. Clinical indicators at time of admission including elevated body temperature, lower oxygen saturation and heart rate at time of admission can be used as significant clinical predictors for prolonged hospitalization in these children.

Authors' contribution

NNA (Conceptualization; Formal analysis; Investigation; Project administration Writing – original draft; Writing – review & editing)

Conflict of interest

None to declare.

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