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Original Research Article

A Retrospective Analysis of Risk Factors, Management Practices, and Clinical Outcomes in Pediatric Pneumonia

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Abstract:

Background: Pneumonia among children is still a significant contributor to hospitalizations and deaths, and these are affected by nutrition, the environment, and clinical issues.

Aim: To study risk factors, management practices, and hospital outcome of childhood pneumonia to determine factors which predict poor outcome.

Methodology: An observational retrospective study was done in a hospital setting involving 200 children ranging from 1 month to 14 years old having pneumonia for one year at Narayan Medical College and Hospital, Sasaram, Bihar. Descriptive and inferential statistics were used for data analysis.

Results: Antibiotics were given to 98.0% of the participants, 39.5% needed oxygen support, and 17.0% of them needed admission to PICU. In general, the recovery rate was 90.5% of the participants and mortality rate was 5.0%. Hypoxemia was the most significant predictor for bad outcome (AOR =5.48, $p<0.001$), followed by underlying comorbidity, chest retractions, and malnutrition.

Conclusion: Early recognition of respiratory severity and other risk factors, along with appropriate treatment, can help improve prognosis for pneumonia in children.

Keywords: Pediatric pneumonia; Risk factors; Hypoxemia; Malnutrition; Clinical outcomes; PICU.

Introduction

Pneumonia continues to be one of the most significant acute respiratory illnesses among children and still plays an important role in the burden of morbidity, hospitalization, and deaths in children, especially in LMICs [1]. The clinical presentation of childhood pneumonia is diverse, and it may include simple respiratory disease through to severe disease with features such as hypoxemia, respiratory difficulty, systemic manifestations, and requiring intensive care unit admission [2]. There are various interrelated factors that may affect the severity of the illness and outcomes, including being young, malnourished, underimmunized, overcrowding in the household, exposure to environmental tobacco smoking, indoor air pollution, and the presence of other diseases [3]. Early identification of deterioration, antibiotics, oxygenation, supportive care, and escalation of care will be important aspects in the management of these cases [4]. Studying the risk factor profile, treatment, and outcome of these patients in the clinical setting could provide useful information for recognizing high-risk patients [5].

Background of the Study

The problem of pediatric pneumonia is one that persists and continues to cause considerable burden to health systems, especially in developing nations where issues such as malnutrition, exposure to pollutants and smoke, delay in seeking treatment, and lack of timely treatment can increase the risk of developing the disease [6]. The risk of contracting the infection and suffering complications may be heightened in cases where children are malnourished, under-immunized, exposed to indoor air pollution or cigarette smoke, live in overcrowded settings, and suffer from any comorbidity diseases [7]. The clinical features such as fast breathing, chest retractions, hypoxemia, problems feeding, and cyanosis can be indicative of increased severity of the disease and impact the need for oxygen and respiratory therapies. While improvements in antimicrobials, vaccinations, supportive treatments, and respiratory care have helped improve survival rates among children admitted to hospitals, complications and mortality still pose considerable challenges [8]. Evaluation of routinely collected information on hospital admissions can help in gaining valuable insights regarding risk factors, management practices, and determinants of poor outcomes [9]. This study was conducted based on

these circumstances in order to identify the risk factors, management approaches, and outcome factors related to pediatric pneumonia and to identify factors associated with unfavourable outcomes among hospitalized children [10].

Risk Factors and Clinical Outcomes of Pediatric Pneumonia: Pediatric pneumonia is a condition that depends on the combined effect of demographic, nutritional, environmental, and clinical risk factors which might affect the vulnerability to infection and the severity of the disease [11]. Younger age, malnutrition, suboptimal immunization, failure of exclusive breastfeeding, overcrowding in the house, exposure to cigarette smoke, indoor air pollution due to the use of biomass fuel, repeated respiratory infections, and existing comorbidities are some of the factors usually related to the development of pneumonia and unfavorable clinical course [12]. In hospitalized children, symptoms like severe breathing difficulty, chest retraction, hypoxia, cyanosis, and feeding problems may be an indication of a more severe disease with higher probability of requiring intensive care interventions [13]. The clinical results of the condition depend on the previous state of health, severity of the disease, the presence of complications, and timely application of treatment measures [14]. Most children recover after successful therapy while the more serious cases need to receive oxygen, respiratory assistance, and be admitted into a pediatric intensive care unit [15].

Research Objectives

The objectives of the study are:

- To assess the demographic and clinical profile of pediatric patients diagnosed with pneumonia during the study period.
- To identify the major nutritional, immunization-related, environmental, and clinical risk factors associated with pediatric pneumonia and adverse hospital outcomes.
- To evaluate the management patterns of pediatric pneumonia, including antibiotic therapy, supportive treatment, oxygen supplementation, respiratory support, and pediatric intensive care requirements.
- To assess the hospital outcomes of pediatric pneumonia and determine the significant predictors of adverse outcomes among affected children.

Methodology

This study was carried out to investigate the demographic features, risk factors, treatment methods, and outcomes of hospitalization for children with pneumonia. The retrospective methodology was used to analyze the data from hospital records within one year. Data on demographic, clinical, treatment, and outcome aspects were obtained from the existing medical files through a well-structured data collection process.

Study Design: This study was a hospital-based, retrospective observational study. The medical history of the pediatric patients who were diagnosed with pneumonia and received treatment for it in the defined study period was analyzed. As this was a retrospective study, there was no need to carry out any kind of intervention for the sake of the study.

Study Area: The research study was conducted in the Department of Pediatrics, Narayan Medical College and Hospital, Sasaram, Bihar, India.

Study Duration: The research was conducted within one year from March 2023 to February 2024.

Study Participants: The subjects of the study were children ages 1 month to 14 years old admitted to the Department of Pediatrics diagnosed with pneumonia based on clinical presentation.

Inclusion and Exclusion Criteria

Inclusion Criteria

Selection criteria included patients who:

1. Aged 1 month to 14 years;
2. Admitted into the hospital with a diagnosis of pneumonia from clinical features, with radiological and/or laboratory features wherever applicable;
3. Admitted to the hospital with pneumonia during the stipulated one year period of study; and
4. Medical records had enough details with respect to clinical features, risk factors, management and hospital outcome.

Exclusion Criteria

The criteria used to exclude patients included the following:

1. The lack of sufficient medical files that could not allow the extraction of important variables necessary for the study.
2. A patient who had been hospitalized for conditions other than respiratory diseases, where pneumonia was just an additional observation.
3. The patient being transferred from another hospital where there was no baseline information due to the administration of intensive therapy; and
4. Patients who were new-borns of less than 1 month old.

Sample Size: The total enumeration method was used since this was a retrospective study design. All the pediatric patients that met the criteria for inclusion into the study during the one-year study period were included into the study. From the available records, those that did not meet the criteria for inclusion and those that did not have enough

information were excluded from the study. The hypothetical number of 200 pediatric patients with pneumonia was thought to be sufficient for this study. This sample size was regarded as adequate for describing the clinical profile, evaluating common risk factors, examining management patterns, and assessing hospital outcomes within the study setting.

Procedure: After getting the required institutional clearance, the medical records of children diagnosed with pneumonia who had been admitted during the study period were reviewed. Cases that fulfilled the inclusion and exclusion criteria were selected for the study. Data were gathered using a specially designed form of data collection sheet. Variables such as age, gender, place of residence, nutrition, immunization status, breastfeeding history, exposure to cigarette smoke or indoor air pollution, overcrowding, previous respiratory infection, and underlying diseases were collected wherever available in the medical record sheets.

Clinical information was obtained through patient symptoms and signs like fever, cough, difficulty in breathing, tachypnea, chest retractions, oxygen saturation, respiratory distress, and other systemic features. Other available information from laboratory and radiological investigations, such as complete blood count and chest X-rays, was also collected. Variables related to the management of the illness comprised the use of antibiotics, oxygen therapy, IV fluids, nebulization or any other form of treatment, respiratory support, and pediatric intensive care unit (PICU) admission. Escalation of respiratory support and other important interventions in treatment, if any, were also noted down. The outcome of hospitalization was evaluated based on clinical improvement and discharge, length of hospitalization stay, PICU requirements, complications, referral, transfer, and in-hospital death. The data obtained was reviewed for any discrepancies and inconsistencies and was entered into the final database for statistical analysis. Patient identifiers and other personal information were not included in the analysis data set.

Statistical Analysis: All the data collected were then subjected to analysis in Microsoft Excel and thereafter using the Statistical Package for Social Sciences (SPSS), Version 26.0. Frequencies and percentages were used for categorical data, while continuous data were expressed in terms of mean and standard deviation or median and interquartile ranges.

The association of categorical risk factors with major clinical outcome was assessed with the use of Chi-square test or Fisher's exact test, where necessary. The continuous variables among relevant outcome groups were compared by means of independent samples t-test or a non-parametric test as per the requirement. The variables having clinical relevance or statistical significance in the primary analysis were taken into consideration for analysis through binary logistic regression model for the independent prediction of poor hospital outcome. The adjusted odds ratio (AOR) with 95% confidence interval (CI) was reported wherever applicable. The significance level of $p<0.05$ was considered.

Results

All patients with pneumonia aged 200 years meeting the inclusion criteria were included in the study. The results were studied with regard to demographics, risk factors, presentation, investigations, treatment practices, and outcomes in the hospitals. Further analysis was performed in order to find an association between clinical/risk factors and poor outcomes among hospital patients in order to understand the reasons for severe cases and poor outcomes.

Table 1: Demographic characteristics of the study participants (N = 200)

Characteristics	Frequency (n)	Percentage (%)
Age group		
1–11 months	52	26.0
1–4 years	88	44.0
5–9 years	39	19.5
10–14 years	21	10.5
Sex		
Male	116	58.0
Female	84	42.0
Residence		
Rural	128	64.0
Urban	72	36.0

The highest number of patients was recorded in the 1–4-year age group (44.0%), followed by the 1–11-month infant age group (26.0%). Among the participants, boys made up 58.0%, and around two-thirds (64.0%) of the patients hailed from rural areas.

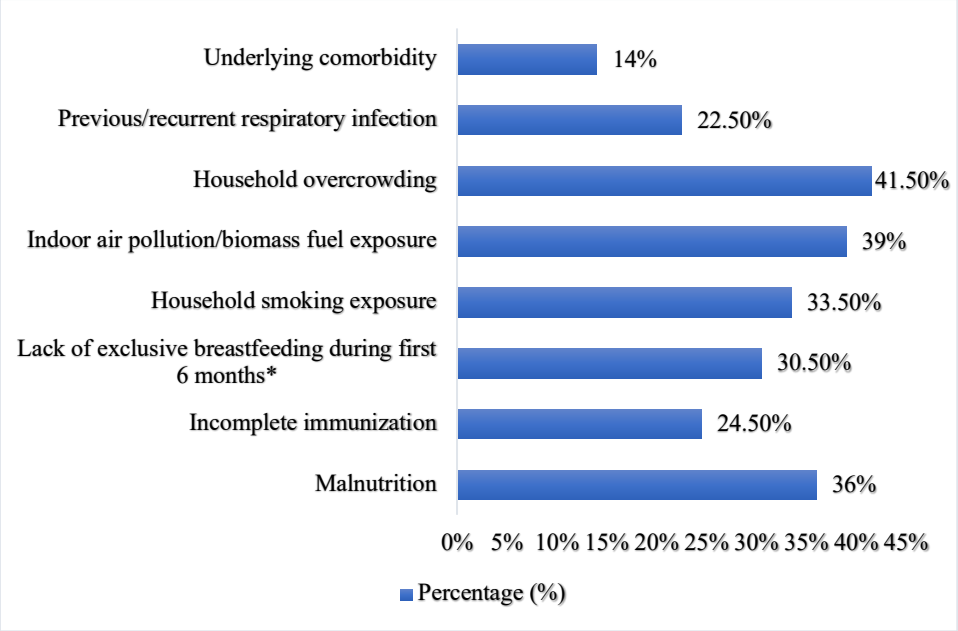

Figure 1: Distribution of documented risk factors among pediatric pneumonia cases

*As documented in available medical records.

The most commonly identified environmental risks included overcrowding at home (41.5%) and indoor air pollution/biomass fuel exposure (39.0%). Malnutrition was found in 36.0% of individuals while household exposure to smoking was 33.5%.

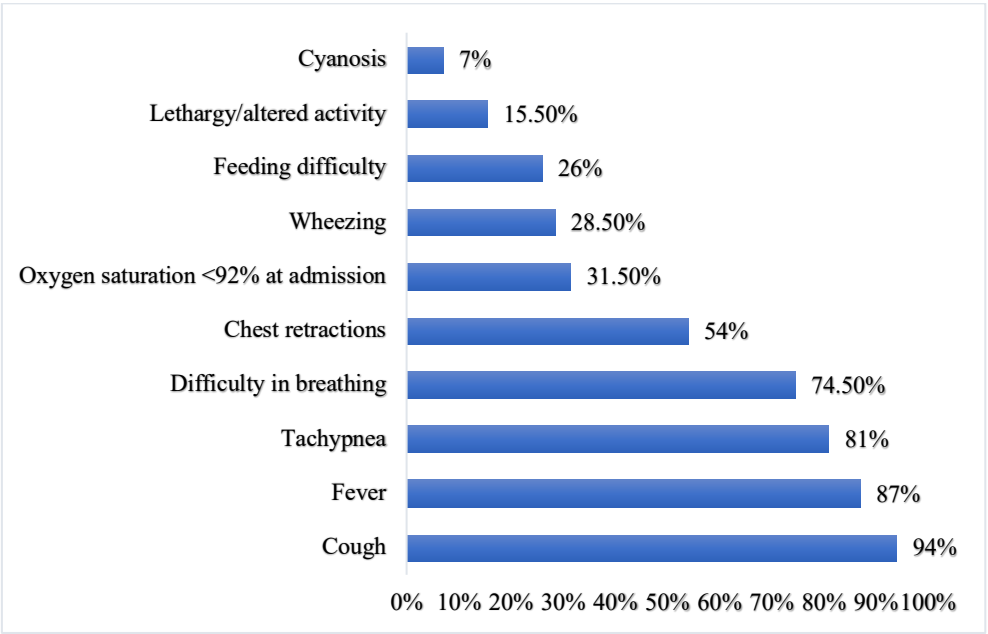

Figure 2: Clinical presentation of pediatric pneumonia cases

Among the common signs and symptoms were coughing (94.0%), fever (87.0%), and tachypnea (81.0%). Breathing difficulty was recorded in 74.5% of patients, whereas 31.5% presented with oxygen saturation lower tha

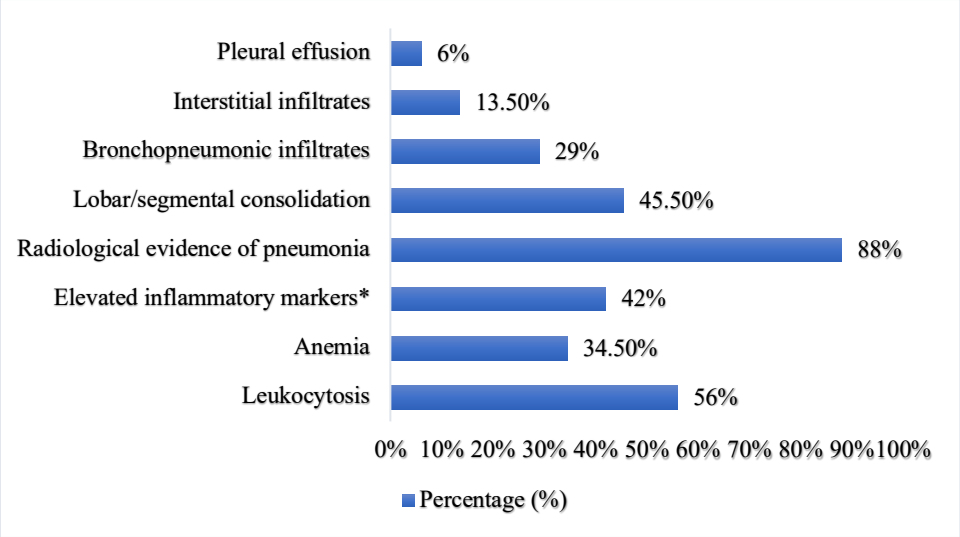

Figure 3: Laboratory and radiological findings among the study participants

*Based on available C-reactive protein and/or other inflammatory marker records.

Leukocytosis occurred in 56.0% of the subjects. Evidence on x-rays compatible with pneumonia was seen in 88.0% of the subjects, while lobar or segmental consolidation was the commonest x-ray finding (45.5%).

Table 5: Management received by pediatric pneumonia patients

Management modality	Frequency (n)	Percentage (%)
Antibiotic therapy	196	98.0
Intravenous fluids	121	60.5
Oxygen supplementation	79	39.5
Nebulization	73	36.5
Antipyretic/supportive therapy	184	92.0
PICU admission	34	17.0
Non-invasive respiratory support	21	10.5
Invasive mechanical ventilation	9	4.5

Antibiotics were prescribed to 98.0% of the patients, while 92.0% received antipyretics. Oxygen therapy was needed in 39.5% of the cases. The PICU admission rate was 17.0%, while 4.5% of the patients needed invasive ventilation.

Table 6: Hospital outcomes of pediatric pneumonia cases

Outcome	Frequency (n)	Percentage (%)
Recovered and discharged	181	90.5
Referred/transferred	9	4.5
In-hospital mortality	10	5.0
Developed one or more complications	31	15.5
PICU admission	34	17.0

Most of the patients (90.5%) improved clinically and were discharged from the hospital. The percentage of complications was 15.5%, whereas the overall mortality rate during the stay in the hospital was 5.0%.

The median length of stay at the hospital was 5 days (IQR 4-7 days). The median length of stay for the patients admitted to PICU was higher at 8 days (IQR 6-11 days) when compared to 5 days (IQR 3-6 days).

For additional analysis, adverse hospital outcome was categorized as PICU admission, referral/transfer, and in-hospital death. Since each patient could have had multiple outcomes within this category, they were categorized only once under the adverse outcome category. Out of all the patients, 43 patients (21.5%) were categorized under adverse hospital outcome, while 157 patients (78.5%) were under favorable outcome.

Table 7: Association of selected risk factors with adverse hospital outcomes

Risk factor	Adverse outcome n/N (%)	Favorable outcome n/N (%)	χ^2	p-value
Malnutrition	25/72 (34.7)	47/72 (65.3)	11.94	0.001
No malnutrition	18/128 (14.1)	110/128 (85.9)		
Incomplete immunization	17/49 (34.7)	32/49 (65.3)	6.38	0.012
Complete immunization	26/151 (17.2)	125/151 (82.8)		
Household smoking exposure	20/67 (29.9)	47/67 (70.1)	4.10	0.043
No smoking exposure	23/133 (17.3)	110/133 (82.7)		
Indoor air pollution	23/78 (29.5)	55/78 (70.5)	4.66	0.031
No documented indoor air pollution	20/122 (16.4)	102/122 (83.6)		
Underlying comorbidity	12/28 (42.9)	16/28 (57.1)	8.34	0.004
No underlying comorbidity	31/172 (18.0)	141/172 (82.0)		

Malnutrition, lack of complete vaccinations, exposure to tobacco smoke in households, indoor air pollution, and comorbidity were significantly correlated with adverse outcomes in hospitals ($p < 0.05$). Adverse outcome rates were especially high for patients with comorbidity (42.9%) and malnutrition (34.7%).

Table 8: Association of clinical severity indicators with adverse hospital outcomes

Clinical factor	Adverse outcome n/N (%)	Favorable outcome n/N (%)	χ^2	p-value
Oxygen saturation <92%	31/63 (49.2)	32/63 (50.8)	41.22	<0.001
Oxygen saturation ≥92%	12/137 (8.8)	125/137 (91.2)		
Chest retractions present	35/108 (32.4)	73/108 (67.6)	15.77	<0.001
Chest retractions absent	8/92 (8.7)	84/92 (91.3)		
Cyanosis present	9/14 (64.3)	5/14 (35.7)	15.69	<0.001
Cyanosis absent	34/186 (18.3)	152/186 (81.7)		
Feeding difficulty present	20/52 (38.5)	32/52 (61.5)	12.14	<0.001
Feeding difficulty absent	23/148 (15.5)	125/148 (84.5)		

Increased respiratory compromise was significantly correlated with adverse events. Almost one-half (49.2%) of the children who presented with oxygen saturation less than 92% had adverse events whereas only 8.8% of those who had oxygen saturation of ≥92% had such events ($p < 0.001$). Other factors that significantly correlated with adverse events included cyanosis, retractions, and feeding problems.

Table 9: Multivariable binary logistic regression analysis of predictors of adverse hospital outcomes

Predictor	Adjusted Odds Ratio (AOR)	95% CI	p-value
Malnutrition	2.31	1.10–4.86	0.027
Incomplete immunization	1.74	0.78–3.89	0.177
Household smoking exposure	1.41	0.66–3.02	0.375
Indoor air pollution	1.52	0.72–3.20	0.271
Underlying comorbidity	2.67	1.06–6.72	0.037
Oxygen saturation <92%	5.48	2.41–12.46	<0.001
Chest retractions	2.38	1.02–5.55	0.045
Feeding difficulty	1.89	0.83–4.30	0.129

Even after adjustments for possible confounders, hypoxemia defined by an oxygen saturation of <92% on admission was found to be the strongest independent risk factor for hospital morbidity (AOR = 5.48; 95% CI: 2.41-12.46, $p<0.001$). Other independent risk factors included malnutrition (AOR = 2.31; $p = 0.027$), presence of comorbid illness (AOR = 2.67; $p = 0.037$), and chest retractions (AOR = 2.38; $p = 0.045$). However, inadequate immunization, second-hand smoke exposure, indoor air pollution, and difficulty feeding did not have statistical significance after adjustment.

In general, results showed that while most of the patients suffering from pediatric pneumonia recovered successfully through proper hospitalization, a significant number of them needed intensive care. Poor nutritional state, preexisting conditions, and indicators of respiratory seriousness, especially hypoxemia and chest retractions, were among the significant factors influencing the outcome of hospitalization for these patients.

Discussion

The current study found that pediatric pneumonia had more impact on the younger children where

44.0% of the cases were in the age range of 1-4 years and 26.0% of the patients were less than one year old. The common symptoms included cough (94.0%), fever (87.0%), tachypnea (81.0%), and breathing problems (74.5%). Hypoxemia was recorded in 31.5% of the patients while hypoxemia turned out to be the most significant independent predictor for bad results (AOR = 5.48, $p < 0.001$). This result agrees with those obtained by Nantanda et al. (2014) [16], who also identified hypoxemia as an important predictor of unfavorable outcomes among children with acute respiratory illnesses.

Overcrowding at home (41.5%), indoor air pollution (39.0%), malnutrition (36.0%), and household exposure to smoking (33.5%) emerged as important risk factors. Independent risk factor for poor outcome in the form of malnutrition was found with an AOR of 2.31, p-value of 0.027. This finding is consistent with those of Chisti et al. (2015) [17] who reported poor outcome in children with severe malnutrition suffering from pneumonia. In the same manner, Harris et al. (2011) [18] showed the contribution of air pollution to childhood pneumonia.

On management, 98.0% of patients were on antibiotics, 39.5% needed oxygen, 17.0% needed PICU, and 4.5% were on mechanical ventilation. In all, 90.5% were discharged, while mortality was 5.0%. Weiss et al. (2014) [19] stressed the significance of the administration of appropriate antibiotic therapy to reduce complications in severe cases in pediatric patients, whereas François et al. (2010) [20] noted serious suppurative complications in cases of pneumonia in children. Generally, the current results revealed that proper treatment led to positive outcomes for most patients, but hypoxemia, malnutrition, comorbidities, and chest retractions were associated with negative outcomes.

Conclusion

The current study has shown that pediatric pneumonia mostly occurred in younger children and was linked to various nutritional, environmental, and clinical risk factors. Household overcrowding, air pollution at home, malnutrition, and smoking in the households were common among children who developed the disease. Among the symptoms of this condition were cough, fever, tachypnea, and difficulty breathing. The majority of the patients showed positive results after being treated with antibiotics and other supportive therapy; 90.5% recovered and were discharged from the hospital, but some of them needed oxygen therapy and intensive care, and there was an in-hospital death rate of 5.0%. Hypoxemia, malnutrition, comorbidity, and chest retraction have been found to be significant independent predictors of unfavorable hospital course of this disease; hypoxemia had the strongest effect on this outcome. The findings emphasize the importance of early identification of high-risk children, prompt assessment of respiratory severity, adequate nutritional care, appropriate antimicrobial and supportive management, and timely escalation of care to reduce complications and mortality associated with pediatric pneumonia.

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