Original Article

The Prognostic Value of C-Reactive Protein Levels in Patients with Community Acquired Pneumonia

Arshia Ijaz, Afsheen Batool Raza and Madiha Tahir

ABSTRACT

Objective: To determine the predictive accuracy of C-reactive protein levels in patients with community-acquired pneumonia in predicting the complications of pneumonia.

Study Design: Cross-sectional study

Place and Duration of Study: This study was conducted at the Pediatric medical unit of The Children's Hospital & UCHS Lahore from 05 December 2024 to 05 May 2025.

Methods: Non-Probability Consecutive Sampling technique used. The calculated with 95% confidence level with 7% margin of error and 80% magnitude 115 cases. A total of 115 children fulfilling the selection criteria were enrolled after taking written informed consent from parents. Clinical proforma was used to record data of the patients, e.g. demographic profile, C-reactive protein value at admission and on day 4, fever, cough, tachypnea, wheezing etc. The outcomes of interest were assessed as: 7-day mortality; need for mechanical ventilation and/or inotropic support; development of complicated pneumonia.

Results: Of these 115 study cases, 78(67.8%) were male patients, while 37(32.2%) were female patients. Mean age of our study cases was 27.65±14.68 months. Of these 115 study cases, 95(82.6%) were vaccinated and 20(17.4%) were un-vaccinated. Mean CRP level in our study was 8.23±6.12 mg/L and it was raised (>10mg/L) in 53(46.1%). Complications were noted in 37(32.2%), while sensitivity, specificity, PPV, NPV and diagnostic accuracy was 83.8%, 71.8%, 58.5%, 90.3% and 75.7%, respectively.

Conclusion: Our study results support use of serum CRP levels in children presenting with severe pneumonia as it was found to be highly sensitive, specific, high positive predictive value & negative predictive value and high diagnostic accuracy. All clinicians treating such patients can employ serum CRP levels for early diagnosis followed by timely management achieve desired outcomes.

Key Words: Pneumonia, Complications, Predictive Accuracy.

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INTRODUCTION

Pediatric community-acquired pneumonia in children can be identified by specific respiratory symptoms. These include cough, sputum production, rapid breathing, high fever, abnormal sounds during breathing, elevated or decreased white blood cell count, and findings on chest X-ray.

This type of pneumonia occurs outside hospitals and triggers a strong inflammatory response. Interleukins associated with CAP prompt the liver to generate the acute phase protein CRP, linked to disease severity prediction and clinical decisions as per current research.[1-3] CAP is a leading cause of death globally, particularly affecting children. Pneumonia contributes significantly to child mortality, with 14.9% of deaths under age five attributed to it. Around 0.9 million children die from pneumonia annually, making it a major cause of pediatric fatalities. Research indicates a range of infectious agents, including viruses and bacteria, causing pneumonia, with viral infections being predominant among patients.[4,5] No proven prognostic methods exist for determining the best site of care for CAP, a crucial decision. Around 48.2% had moderate to severe disease. Despite being a common cause of global deaths, CAP incidence decreased between 2000 and 2013 due to improved healthcare access, nutrition, vaccinations, and lifestyle changes, impacting its etiology, epidemiology, and mortality.[4,6] In a study of 1,222 community-acquired pneumonia patients, CRP levels were analyzed in 268 patients with specific diagnoses. Mean CRP levels were different in patients with various types of pneumonia. The sensitivity, specificity, and predictive values at a 25 mg/dL cut-off were 0.6, 0.83, 0.3, and 0.94.[7]According to UK research by Dr. Robin P. Smith, CRP is a sensitive marker for

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pneumonia. A persistently high CRP level suggests antibiotic failure or new infection. The study suggests CRP, not TNF or IL-6, as a pneumonia marker. In a 2008 study, a CRP level below 100 mg/L at admission indicated lower 30-day death risk. Failure to reduce CRP by 50% after day 4 signals poor prognosis in community-acquired pneumonia, making CRP an independent severity indicator.[8,9]Unfortunately, there is very limited data available on severity assessment tools for CAP in Asia particularly Pakistan. Owing to different demographic, environmental, socioeconomic and regional status of Pakistan especially central and southern Punjab regions, this study is proposed to study prognostic value of CRP in children of these regions which mostly come to Lahore for the treatment. Proper assessment is very important for better management of CAP and to make the policies for its prevention in the region in order to meet the sustainable development in the country.

METHODS

The prospective cross-sectional study was conducted at Children's Hospital and Institute of Child Health Lahore from 05 December 2024 to 05 May 2025. An informed consent of guardian was taken. Patients mentioned in the inclusion criteria who have diagnosed community acquired pneumonia were selected by non-probability consecutive sampling. A sample size of 115 was calculated with 95% confidence level, with 13% margin of error, expected sensitivity and specificity of CRP as 60% and 83% with expected prevalence of complications as 48.2%.[6,7]

Patients who signed consent form, in the age range 6 months to 56 months and those who were recently diagnosed as severe community acquired pneumonia according to operational definition were included in this study. Patients not willing for study, age below 6 months or above 56 months, patients with other respiratory ailments and patients being managed on OPD basis were excluded from this study. Clinical proforma was used to record data of the patients e.g. demographic profile, C-reactive protein value at admission, fever, cough, tachypnea, wheezing etc. The outcomes of interest were assessed as: 7-day mortality; need for mechanical ventilation and/or inotropic support; development of complicated pneumonia (lung abscess, empyema, or complicated para pneumonic effusion) etc. Data was analyzed using SPSS version 23.0. Characteristics of the population under study were noted in terms of frequencies. Qualitative variables e.g. gender and complications on both techniques were expressed as percentage or number while numerical variables e.g. age and CRP levels were expressed as mean and standard deviation. Predictive accuracy of CRP was calculated. Data was stratified with regards to gender and age. Post-stratification, predictive accuracy was calculated.

Operational definitions

Community Acquired Pneumonia

Cough, sputum production, tachypnea for age, a core body temperature > 38.0, rhonchi or cretps on auscultation, TLC > 10 or < $4*10^9$ cells L-1, and infiltrates on chest X-ray.

C Reactive protein

The acute phase protein C-reactive protein (CRP), produced by liver in response to IL-6, is used to either identify inflammation brought on by acute diseases or to track the progression of disease in cases of chronic conditions. CRP levels over 10 mg/L was regarded as positive in this investigation. CRP was measured at admission**.**

True Positive CRP

CRP > 10mg/L with any of the above mentioned complications.

True Negative CRP

CRP < 10mg/L and absence of any above complications.

False Positive CRP

CRP > 10mg/L and absence of any above complications.

False Negative CRP

CRP < 10mg/L and presence of any of above complications.

Sensitivity

TP/TP+FNx100

Specificity

TN/TN+FPx100

Positive Predictive Value (PPV)

TP/TP+FPx100

Negative Predictive Value (NPV)

TN/TN+FNx100

RESULTS

Our research comprised a total of 115 individuals who met the specific criteria set for selection in our study. Among these 115 cases under investigation, 78 individuals, constituting 67.8% of the total, were male, whereas the remaining 37 individuals, making up 32.2%, were female. The average age of the participants in our study was calculated to be 27.65±14.68 months, with the youngest individual being 6 months old and the oldest being 56 months old. Our findings have revealed that a significant portion of our study population, specifically 77 individuals, which accounts for 67.0%, were aged ≤30 months. Within the cohort of 115 subjects, 43 individuals, representing 37.4%, resided in rural areas, while 72 individuals, constituting 62.6%, lived in urban settings. An assessment of the socio-economic status disclosed that 38 individuals, amounting to 33.0%, were identified as having a poor socio-economic background, whereas 77 individuals, making up 67.0%, belonged to the middle-income category. The average duration of the disease among the participants was determined to be 8.43±4.32

days, with 69 individuals, accounting for 60.0%, reporting an illness duration exceeding one week. Out of the 115 individuals included in the study, 95 individuals, representing 82.6%, had received vaccinations, while the remaining 20 individuals, making up 17.4%, were not vaccinated. The mean level of C-reactive protein (CRP) in our study was documented as 8.23±6.12 mg/L, with levels exceeding 10mg/L observed in 53 individuals, constituting 46.1%. (Table 1). Complications associated with the condition were observed in 37 individuals, representing 32.2% of the study population(Fig:1) while the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated to be 83.8%, 71.8%, 58.5%, 90.3%, and 75.7%, respectively. Regarding distribution of CRP level with regards to complications, Of the 53 people who tested positive for CRP, 31 (58.49%) experienced complications, and 22 did not. In contrast, out of 62 people with a CRP of negative, only 6 (9.68%) experienced complications, whereas 56 did not. This suggests a substantial correlation between elevated CRP levels and a higher chance of complications. (Fig 2).

Table No.1: Frequency distribution of different variables

Gender	**Frequency**	**Percent**
Male	78	67.8
Female	37	32.2
Total	115	100.0
Age groups		
≤30 months	77	67.0
>30 months	38	33.0
Total	115	100.0
Duration of disease		
≤1 week	46	40.0
>1 week	69	60.0
Total	115	100.0
Vaccination		
Yes	95	82.6
No	20	17.4
Total	115	100.0
CRP		
Positive	53	46.1
Negative	62	53.9
Total	115	100.0

The ability of C-reactive protein (CRP) to predict complications can be elucidated by stratifying diagnostic accuracy by age. Whereas CRP-negative data indicate 6 and 35 instances of complications, CRP-positive results in newborns ≤30 weeks correspond with 25 occurrences of complications and 11 without. While CRP-negative findings indicate 0 and 21, CRP-positive results in newborns older than 30 weeks are associated with 6 occurrences of complications and 11 without. Clinical professionals can better manage baby health by customizing CRP tests based on age with the use of this data. (Fig 3)

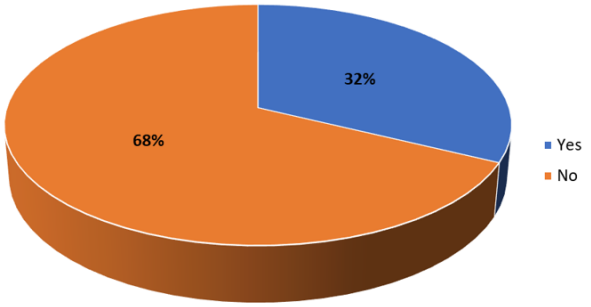

Figure No.1: Distribution of complications

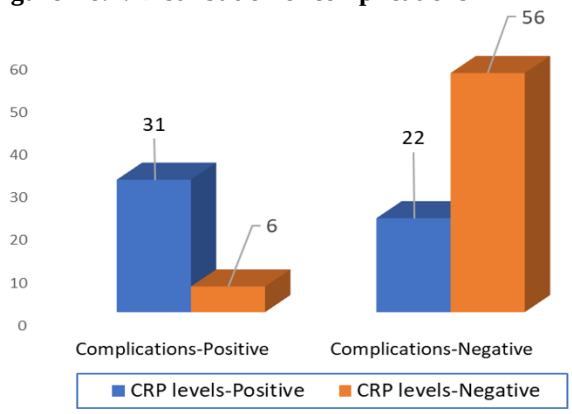

Figure No.2: Distribution of CRP levels with regards to complications

P value is 0.001 which is significant
Sensitivity = 83.78 % Specificity= 71.79 % PPV = 58.49 % NPV = 90.32 %
Diagnostic Accuracy = 75.65 %

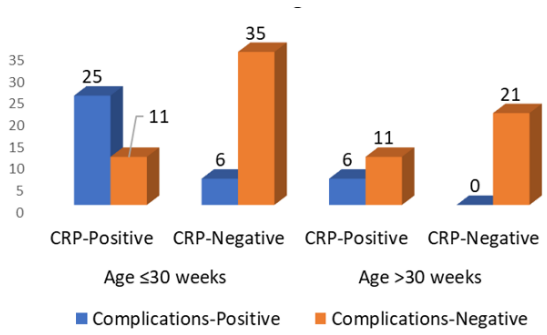

Figure No.3: Stratification of diagnostic accuracy with respect to age

P value is 0.001 which is significant
Age ≤ 30 weeks: Sn=80.6%, Sp=76.1%, PPV=69.4%, NPV=85.3%, DA=77.9%
Age > 30 weeks: Sn=100.0%, Sp=65.6%, PPV=35.3%, NPV=100.0%, DA=71.1%

DISCUSSION

Childhood pneumonia, a leading cause of death under age 5, sees higher prevalence in developing (0.29 cases per child-year) than developed countries (0.05). Globally, 156 million new cases occur annually, mostly

in developing countries like India, China, and Pakistan. Risk factors include lack of breastfeeding, under-nutrition, indoor pollution, low birth weight, crowding, and no measles immunization. Pneumonia contributes to 19% of under-5 deaths, with most in sub-Saharan Africa and south-east Asia. Studies connect Streptococcus pneumoniae, Haemophilus influenzae, and respiratory syncytial virus to childhood pneumonia.[10]Pneumonia is an important cause of illness and leading cause of death in young children in developing countries. More than 99% of pneumonia deaths occur in low- and middle-income countries (LMICs). The recent estimate is a median incidence of 0.22 episodes per child year with severe pneumonia contributing to 11.5% in LMICs.[11-12]The World Health Organization estimated 156 million new pneumonia cases globally annually, with the majority in developing countries. Pneumococcus is the main bacterial cause in these regions, along with H. influenzae type b, S. aureus, and K. pneumoniae. Treatment for childhood CAP should consider age and likely pathogens due to limited early diagnosis, often leading to empirical treatment.[13]Several attempts to understand global child pneumonia mortality over 30 years have faced challenges in estimating due to varying pneumonia definitions, low verbal autopsy specificity, symptom overlap with malaria, difficulty in distinguishing pneumonia from sepsis in neonates, and multiple disorders contributing to a single death. Pneumonia remains consistently identified as the main cause of childhood mortality. Our study included 115 patients meeting inclusion criteria, with 67.8% males and 32.2% females. Similar trends were seen in other studies by Tagarro et al, Mandal et al, and Yadav et al, with Fritz et al reporting different results.[14-17] The mean age of our study cases was 27.65±14.68 months. Most cases, 77(67.0%), were under 2.5 years. This was due to our inclusion criteria of patients aged 6-56 months. Fritz et al. reported a higher mean age of 4.7±5 years, and Tagarro et al. reported 4.67±0.39 years, attributing the differences to similar exclusions.[14,17] Mean disease duration was 8.43±4.32 days and 69(60.0%) had duration of illness more than 1 week. Fritz et al[17] from Iran reported 10.8 days mean disease duration which is close to our study results. Tagarro et al[14] reported similar results. In our study, the mean CRP level was 8.23±6.12 mg/L, with 46.1% having elevated levels (>10mg/L). Complications were seen in 32.2%. Our study found sensitivity of 83.78%, specificity of 71.79%, PPV of 58.49%, NPV of 90.32%, and diagnostic accuracy of 75.65%. Similar results were reported by Omran et al (90% sensitivity, 40% specificity, 62% PPV, and 79% NPV) and Alcoba et al (83.7% sensitivity, 50% specificity, 50% PPV, and 84.3% NPV) in children with pneumonia.[18-19]

CONCLUSION

Our study results support use of serum CRP levels in pediatric population presenting with severe pneumonia as it was found to be highly sensitive, specific, high positive predictive value & negative predictive value and high diagnostic accuracy. All clinicians treating such patients can employ serum CRP levels for early diagnosis followed by timely management achieve desired outcome.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Arshia Ijaz, Afsheen Batool Raza
Drafting or Revising Critically:	Arshia Ijaz, Madiha Tahir
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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