

Original Research Article

Evaluation of clinical, hematological and radiological parameters among Bangladeshi children with pneumonia

Tohmina Yasmin*, Nibedita Paul, Nadia Nurat, Nevis Wadia

Department of Paediatrics, Delta Medical College, Dhaka, Bangladesh

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*Correspondence:

Dr. Tohmina Yasmin,

E-mail: tohminarmc@gmail.com

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ABSTRACT

Background: Pneumonia is a leading cause of death among children under 5 years worldwide and poses a major burden in Bangladesh. This study compared the clinical, hematological, and radiological features of pneumonia among Bangladeshi children.

Methods: This case-control study was conducted at the Institute of Child Health (ICH) and Shishu Sasthya Foundation (SSF), Dhaka, from July to December 2012. Fifty children with clinically and radiologically confirmed pneumonia were enrolled as cases, along with 50 age-matched children with common cold as controls. All participants underwent clinical evaluation, complete blood count, and chest X-ray. Data were analyzed using the chi-square test and independent sample t-test in SPSS version 26.

Results: Most cases were male (72%) and aged 7–12 months (58%). Fast breathing, chest indrawing, and crepitations were present in all cases but absent in controls. Anemia occurred in 84% of cases versus 44% of controls. Cases had significantly higher WBC counts (14432 ± 2144 vs. 8310 ± 853) and neutrophil percentages (71.22 ± 10.03 vs. 55.08 ± 7.11), while MCV, MCH, and MCHC were significantly lower. Chest X-ray showed patchy opacity in 86% and consolidation in 14% of cases.

Conclusions: Pneumonia in Bangladeshi children was characterized by distinct clinical features, leukocytosis, neutrophilia, and microcytic hypochromic anemia, with patchy opacity as the predominant radiological finding. Integrating clinical, hematological, and radiological assessments may improve diagnosis, evaluation, and management.

Keywords: Pneumonia, Hematological parameters, Radiological findings

INTRODUCTION

Pneumonia is the leading cause of death from infectious diseases globally, responsible for about 14% of all child deaths under five years of age.¹ The burden is particularly high in low- and middle-income countries (LMICs), with South Asia and sub-Saharan Africa accounting for the highest proportion of cases and deaths.² Bangladesh is a lower-middle-income country with a high population density, and still has a significant burden of childhood pneumonia, especially in infants and children under 2 years of age.³ Although there have been improvements in

vaccination coverage, such as Hemophilus influenzae type b (Hib) and pneumococcal conjugate vaccines, pneumonia remains a significant cause of hospitalisation in children in Bangladesh.⁴

Pathophysiology of pneumonia is the infection of the lower respiratory tract with bacteria, viruses or mixed organisms, leading to a complex immunological response. This response is often manifested as changes in hematological parameters such as leukocytosis, neutrophilia and anaemia.⁵ Children with pneumonia have been found to have significantly higher white blood

cell counts and percentages of neutrophils than healthy children in studies from different regions, which is indicative of the host inflammatory response to infection.⁶ In resource-limited areas where microbiological confirmation of pneumonia is often unavailable, these hematological changes, together with the characteristic clinical features of fast breathing, chest indrawing and crepitations on auscultation, are the basis for the diagnosis of pneumonia.⁷

Anemia is a frequent co-morbidity in pneumonia in children, especially in developing countries and is suspected to aggravate the clinical condition by decreasing the oxygen carrying capacity in the background of a weakened respiratory system.⁸ Iron-deficiency anemia, as indicated by low mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) is the most common nutritional deficiency in children in Bangladesh and could be a factor in susceptibility to respiratory infections.⁹ Nutritional anemia and pulmonary infection form a vicious circle of vulnerability, which requires comprehensive hematological evaluation in the clinical assessment of pneumonia in children. Chest X-ray is a useful adjunct in the radiological assessment of childhood pneumonia and can help identify consolidation or patchy opacities, which support clinical suspicion and direct treatment.¹⁰

Although the WHO clinical case definition is a pragmatic approach for diagnosis in the field, radiological confirmation is useful for excluding other causes of respiratory distress, including bronchiolitis, cardiac failure, or tuberculosis.¹¹ Although hematological and radiological parameters are important in the diagnosis of pediatric pneumonia, there is limited information available for the Bangladeshi pediatric population. The purpose of this study is to assess and compare the clinical, hematological and radiological parameters of children aged 7 months to 2 years with pneumonia with age-matched controls.

METHODS

This case-control study was carried out at the Institute of Child Health (ICH) and Shishu Sasthya Foundation (SSF), Dhaka, Bangladesh, between July 2012 and December 2012. The study included 100 children aged 7 months to 2 years, consisting of 50 cases and 50 controls. Children were included if they had clinical signs of pneumonia (fever, cough, fast breathing (age-specific respiratory rate criteria), chest indrawing, and crepitations on auscultation) with radiological evidence of consolidation or patchy opacity on chest X-ray.

Children attending the outpatient department with symptoms of common cold (runny nose and cough) but without fast breathing, chest indrawing, or radiological changes were considered as controls and age-matched with the children with pneumonia. Purposive consecutive sampling was used to select participants. Children were

excluded if they had congenital heart disease, tuberculosis, severe acute malnutrition, or thalassemia, since these diseases may have an independent effect on clinical, hematological, or radiological parameters. The exclusion of bronchiolitis was based on clinical and radiological features and a normal leukocyte count.

Demographic and clinical data, such as age, sex, weight, height, body temperature, duration of fever, duration of cough, presenting symptoms and physical signs, were noted on a structured questionnaire after enrolment. Laboratory tests performed were complete blood count (CBC), which included hemoglobin (Hb), total white blood cell (WBC) count, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).

Peripheral blood film examination and serum ferritin were done when hemoglobin was less than 11 gm/dL. All participants had a chest X-ray to detect pneumonic consolidation or patchy opacity. Anemia was classified as mild (Hb 9.5-11 gm/dL), moderate (Hb 8-9.5 gm/dL), or severe (Hb <8 gm/dL). The data were entered, cleaned, and analyzed using SPSS version 26. Categorical variables were presented as frequencies and percentages, and continuous hematological parameters were presented as mean $\pm$ standard deviation.

RESULTS

The age and sex distribution of the study participants are shown in Table 1. Among the cases, 58% were aged 7-12 months and 42% aged 12-24 months, with a mean age of 12 ± 0.03 months. In the control group, 62% were aged 7-12 months and 38% aged 12-24 months, with a mean age of 11 ± 0.01 months. In both cases, males were in the majority (72% of cases and 76% of controls).

The distribution of the duration of fever and cough is shown in Table 2. In cases, most had fever for 3-4 days (62%), and in controls, 68% had fever for 1-2 days. Likewise, cough duration of 3-4 days was most frequent in cases (62%), and 68% of controls had cough lasting 1-2 days. Only the case group had symptoms lasting for 5-6 days or longer.

The clinical presentation of the study participants is described in Table 3. All cases had fast breathing, chest indrawing, and crepitations, whereas all controls did not have any of these. In 46% of cases, but in none of the controls, reluctance to feed was reported. Twenty percent of cases and 8% of controls vomited. Convulsions occurred in 4% of cases, and cyanosis occurred in 4% of cases, but not in controls.

Table 4 shows the distribution of hemoglobin levels. Of the cases, 16% had no anemia, 40% mild anemia, 32% moderate anemia and 12% severe anemia. In the control group, 56% were not anemic, 38% were mildly anemic, and 6% were moderately anemic, but none were severely anemic.

The hematological parameters of both groups are shown in Table 5. Cases had significantly higher mean WBC count (14432 ± 2144 vs. 8310 ± 853 , $p=0.001$) and neutrophil percentage (71.22 ± 10.03 vs. 55.08 ± 7.11 , $p=0.001$) compared to controls. The mean MCV, MCH and MCHC were significantly lower in cases than in controls (all $p=0.001$), suggesting microcytic hypochromic anemia in the pneumonia group.

The radiological findings are summarized in Table 6. Patchy opacity was the most common finding in cases (86% of children), and pneumonic consolidation was seen in 14% of children. All the control subjects had normal chest X-ray, which further supports the specificity of these chest X-ray findings for the diagnosis of pneumonia.

Table 1: Age and sex distribution of the children (n=100).

Variables	Category	Case (n=50) (N)	(%)	Control (n=50) (N)	%
Age in months	7-12 months	29	58	31	62
	12-24 months	21	42	19	38
	Mean $\pm$ SD	12 $\pm$ 0.03		11 $\pm$ 0.01	
Sex	Male	36	72	38	76
	Female	14	28	12	24

Table 2: Distribution of duration of fever and cough among the children (n=100).

Variables	Duration	Case (n=50) (N)	%	Control (n=50) (N)	%
Duration of fever	1-2 days	9	18	34	68
	3-4 days	31	62	16	32
	5-6 days	10	20	0	0
Duration of cough	1-2 days	8	16	34	68
	3-4 days	31	62	16	32
	5-6 days	11	22	0	0
	>6 days	1	2	0	0

Table 3: Clinical presentation of the children (n=100).

Clinical presentation	Response	Case (n=50) (N)	%	Control (n=50) (N)	%
Fast breathing	Yes	50	100	0	0
	No	0	0	50	100
Chest indrawing	Yes	50	100	0	0
	No	0	0	50	100
Vomiting	Yes	10	20	4	8
	No	40	80	46	92
Reluctant to feed	Yes	23	46	0	0
	No	27	54	50	100
Convulsion	Yes	2	4	0	0
	No	48	96	50	100
Crepitation	Yes	50	100	0	0
	No	0	0	50	100
Cyanosis	Yes	2	4	0	0
	No	48	96	50	100

Table 4: Distribution of hemoglobin levels of children (n=100).

Group	No anemia / (N)	%	Mild anemia 9.5-11 gm/dl / (N)	%	Moderate anemia 8-9.5 gm/dl / (N)	%	Severe anemia <8 gm/dL / (N)	%
Case (n=50)	8	16	20	40	16	32	6	12
Control (n=50)	28	56	19	38	3	6	0	0

Table 5: Hematological parameters of the children (n=100).

Hematological parameters	Case (n=50) / Mean±SD	Control (n=50) / Mean±SD
WBC	14432±2144	8310±853
Neutrophils	71.22±10.03	55.08±7.11
MCV	65.22±9.45	76.04±7.86
MCH	17.17±3.85	24.18±3.97
MCHC	25.80±5.28	30.54±2.33

Table 6: Radiological findings of the study population (n=100).

Radiological findings	Case (n=50) / N (%)	Control (n=50) / N (%)
Pneumonic consolidation	7 (14)	0 (0)
Patchy opacity	43 (86)	0 (0)

DISCUSSION

This case-control study compared clinical, hematological, and radiological parameters of Bangladeshi children aged 7 months to 2 years with pneumonia and age-matched controls. The results indicate that there are important differences in several domains that could be useful in the clinical and laboratory diagnosis of childhood pneumonia in resource-limited settings. In terms of age and sex distribution, our results indicated that most pneumonia cases were aged 7-12 months (58%), which is similar to the age distribution of pneumonia reported in South Asia, where infants aged less than 1 year are most vulnerable to pneumonia because they have an immature innate immune system and low vaccine-induced immunity at this age.¹²

The male predominance of cases (72%) and controls (76%) is consistent with the study by Dagne et al from the region, indicating that males were more vulnerable to respiratory infections in early childhood, possibly due to behavioral and immunological differences.¹³ The clinical course of very long fever and cough in cases compared to controls is consistent with the progressive nature of lower respiratory tract infections. All cases had fast breathing, chest indrawing, and crepitations, which are all part of the WHO case definition criteria for pneumonia diagnosis, which has been validated in several low-income country settings.¹⁴ During triage in emergencies, feeding reluctance is an important clinical sign of disease severity and should be addressed in 46% of cases.¹⁵

In our study, the hematological parameters showed significantly higher WBC count and neutrophil percentage in pneumonia cases than in controls, which is in line with Don et al.¹⁶ Neutrophilic predominance leukocytosis is a supportive diagnostic marker in the absence of microbiological investigation and is a host immune response to bacterial pulmonary infection.¹⁷ The leukocytosis in our study (mean WBC 14432/ μ L in cases) is similar to that reported in bacterial pneumonia in children from similar settings.¹⁸ A very notable finding was the significantly lower MCV, MCH, and MCHC in

cases than controls, indicating that iron-deficiency anemia with microcytic hypochromic red cell indices is significantly more common in children with pneumonia. Only 16% of cases were free of anemia compared to 56% of controls, with 12% of cases having severe anemia. Rabaan et al have suggested that iron deficiency could affect mucosal immunity, the bactericidal activity of neutrophils, and consequently increase the susceptibility of children to more severe and prolonged respiratory infections.¹⁹

Pneumonia and anemia are a double burden that further reduces oxygen delivery in a hypoxic situation and requires a combined approach of nutritional and antimicrobial treatment.²⁰ Radiologically, patchy opacity was the most common finding (86%), and only 14% had lobar consolidation. This distribution is similar to bronchopneumonia, being the most common radiological pattern in children under 2 years of age, as reported by the pediatric centers of developing countries.²¹ The lack of radiological changes in controls further supports the specificity of chest X-ray in the diagnosis of pneumonia when used in conjunction with clinical data.²²

The use of chest X-ray with hematological parameters can significantly enhance the diagnostic accuracy, especially in areas where microbiological culture and sensitivity testing are not available.²³ The results of these studies all support the value of a combined clinical, hematological, and radiological approach to the diagnosis of childhood pneumonia. The presence of significant anemia in addition to leukocytosis in children with pneumonia has therapeutic implications and warrants nutritional supplementation in addition to antibiotic therapy in this group.

Limitations

The small number of cases (n=100) may limit the generalizability of the findings of this study. Furthermore, the lack of microbiological assessment does not allow for distinguishing bacterial and viral causes of pneumonia.

CONCLUSION

This study demonstrates that the clinical, hematological, and radiological characteristics of children with pneumonia aged 7 months to 2 years are different from those of case and age-matched controls. Clinical signs of pneumonia in this age group include fast breathing, chest indrawing, crepitus, and refusal to feed. The presence of significant leukocytosis and neutrophilia suggests an active inflammatory response to infection, whereas the markedly reduced MCV, MCH, and MCHC values suggest the presence of coexisting microcytic hypochromic anemia in pneumonia cases. The high prevalence of anemia, including severe anemia, highlights the importance of nutritional assessment and supplementation in addition to antimicrobial therapy. Radiologically, bronchopneumonia with patchy opacity was the most common pattern, which is typical of viral or mixed-organism etiology in young children. The combination of clinical examination, complete blood count, and chest X-ray is a complete and cost-effective diagnostic strategy for childhood pneumonia in resource-limited settings like Bangladesh.

Recommendations

Further studies may include microbiological investigation, such as blood culture and nasopharyngeal swabs, to determine specific causative pathogens and their hematological correlates. Larger sample size multicenter studies are recommended to set the normative hematological thresholds for diagnosis of pneumonia in Bangladeshi children.

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