Original Article

Association of Iron Deficiency Anemia with Pneumonia in 6 Months to 5 Years Old Children

Akther N[1], Ghosh UK[2], Sufian A[3], Hafiz F[4], Banu NA[5], Bhuiyan MM[6], Islam T[7]

Abstract

Background: *Pneumonia is the leading cause of childhood death under five years old in developing countries. Anemia is the commonest ailment affecting health, socio-economic development and the overall betterment of mankind. This study was conducted to determine the association between iron deficiency anemia (IDA) and pneumonia in the age group 6 months to 5 years.* ***Methods:*** *A cross-sectional analytical study was conducted in the Department of Pediatrics, SSMC & Mitford Hospital. According to selection criteria, 64 patients with pneumonia were considered as cases and matched 64 patients with fever and cough and but having no pneumonia, participated as control. Chest X-ray and complete blood count with RBC indices, iron profile was done to see pneumonia and IDA. A comparison was done between two groups. p-value was significant when < 0.05.* ***Results:*** *The mean age was 18.65±16.43 months in the case group and 14.17±10.76 months in the control group. Male was found 65.6% in the case and 73.4% in the control group. Females were 34.4% in the case and 26.6% in the control group. No significant difference in age and sex between the two groups. Decreased level of Hb, RBC, MCV, MCHC & increase RDW and also decreased level of serum iron, ferritin, transferrin & increased TIBC in the case group; all of which were statistically significant when compares to the control group. IDA was 65.6% in the case group; 17.2% in the control group. IDA was significantly higher in the case group compared to the control group.* ***Conclusion:*** *Sixty-six percent of children of 6 months to 5 years of both sexes with pneumonia associated with IDA. So, Iron deficiency anemic child more risk of developing pneumonia.*

Key words: IDA, Pneumonia in children

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Introduction

Pneumonia is the main cause of death globally among children younger than age 5 years were found 1.2 million (18%) death annually. Children below 5 years of age suffer about 5 to 6 episodes of pneumonia per year. Pneumonia affects children everywhere but is most prevalent in South Asia and Africa. Children can be protected from pneumonia, it can be prevented with a simple intervention, and treated with low cost, low-tech medical care[1].

Particularly noteworthy are cases of pneumonia course with the aggravated premorbid background or accompanying pathology. Among many factors that may complicate the pneumonia course is iron deficiency. In recent years there has been an increase in the number of patients with pneumonia among children of an early age, occurring in combination with iron deficiency anemia[2].

Anemia is the most common ailment affecting human health, socioeconomic development and the overall betterment of mankind. Nutritional deficiency, particularly iron deprivation, is the most common cause of anemia. Iron is the essential element for cellular respiration, oxygen transport, being involved in the maturation of numerous proteins and enzymes that play a role in DNA synthesis, cell growth, and immune defense. Iron deficiency is considered a health problem worldwide mainly due to widespread persistence despite improved nutrition and access to substitution treatment. At the same time, anemia is one of the most common diseases in pediatric practice, having in most cases as trigger pathogenic factor that deficiency of iron.

The process of iron deficiency anemia may have multifaceted clinical consequences, not only directly related to impaired erythropoiesis but also marked impairment of oxidative metabolism, cellular immune mechanism, cellular energetics. Iron deficiency with or without anemia is accompanied by reduced aerobic performance and subjective complaints of poor physical condition[3]. The main

[1] Dr. Naima Akther, Medical officer, Dept. of Pediatrics, SSMC & Mitford Hospital, Dhaka, Bangladesh.
[2] Dr. Uzzal Kumar Ghosh, Assistant Professor, Dept. of Pediatrics, Khwaja Yunus Ali Medical College & Hospital, Sirajgonj, Bangladesh.
[3] Dr. Abu Sufian, Assistant Professor of Pediatrics, Eastern Medical college and Hospital, Cumilla, Bangladesh.
[4] Dr. Faeqa Hafiz, Medical officer of Pediatrics, Dhaka Medical College and Hospital, Dhaka, Bangladesh.
[5] Prof. Dr. Nazneen Akhter Banu, Professor of Pediatrics, SSMC & Mitford Hospital, Dhaka, Bangladesh.
[6] Dr. Md Moniruzzaman Bhuiyan, Assistant Professor of Pediatrics, SSMC & Mitford Hospital, Dhaka, Bangladesh.
[7] Dr. Tithi Islam, Consultant Paediatrics (OSD), National Institute of Neuroscience and Hospital, Dhaka, Bangladesh.

Address of Correspondence: Dr. Naima Akhter, Medical Officer (outdoor), Department of Paediatrics, Sir Salimullah Medical College (SSMC) & Mitford Hospital, Dhaka, Bangladesh. Mobile: +8801706314718, Email: akhterakhtero8@gmail.com

symptoms of pneumonia in children are fever, cough and tachypnea. The interaction between iron and infection has been the subject of debate in nutritional immunology, primarily because iron deficiency impairs component of cell-mediated immunity[4]. Since infection of the lower respiratory tract are the major morbidity and mortality indicators among the children, attempts to control the risk factors would have a great effect on the wholesome growth and development of children[5].

It is unclear to what extent iron deficiency affects the individual during the infectious process. Although studies show that infectious processes cause a decrease in plasma iron and this mineral is known to be a major constituent of Hb, few studies analyze the direct effects of subclinical infection on Hb concentration.

The relation between acute lower respiratory tract infection and iron deficiency is supported by mechanism in which mediators of inflammation such as TNF-α (Tumor necrosis factor), INF-ɤ (Interferon), IL13 (Interleukin) and IL6 which play a role in the activation of monocyte and neutrophils, can induce the synthesis of proteins associated with iron metabolism. Some with a blocking effect on the duodenal iron absorption, but also inhibiting the liver, spleen iron recycling resulting in iron deficiency[6].

Iron deficiency is frequently identified during 6 months to 5 years on the one hand due to the loss of iron stock taken from the mother during the last trimester of pregnancy and on the other hand to the lack of iron intake due to the food diversification and exploration period. At the same time, this age coincides with the recording of most episodes for lower respiratory tract infection[6].

Prevention of iron deficiency is essential as previous studies highlighted the adverse effects of iron deficiency on cognitive development, attention, behavior, school performance and physical activity in children. Furthermore, iron deficiency is also associated with impaired immune-competence and therefore can lead to increased morbidity[6]. Much research has been conducted in recent decades to determine prognostic factors for adverse outcome in patients hospitalized for pneumonia including concomitant diseases and laboratory parameters on admission[3].

Whatever the etiology of anemia, the relation between it and pneumonia has not been fully evaluated and only a few reports are available evaluating this subject. Hence this study was aimed to determine the relationship between IDA as a risk factor for pneumonia among children age 6 months to 5 years.

Materials & Methods

It is a cross-sectional analytical study done from January 2019 to October 2019 at the Department of Pediatrics, Sir Salimullah Medical College & Mitford Hospital (SSMC & MH), Dhaka. Ethical clearance was taken from the Ethical Review Committee.

Six months to 5 years old all diagnosed pneumonic children were recruited as Case groups; while age-matched febrile children without any episode of pneumonia considering the Control group. Severe acute malnutrition, congenital heart disease, immune-compromised children, tuberculosis were excluded from this study.

Purposive sampling was done and calculated sample size 128 (N) where each group was 64. Informed written consent was taken from the legal guardian. Details history, clinical examination findings were noted. Blood samples were collected to see anemia and a chest X-ray was done for diagnosis of pneumonia from both Group.

Data were collected in a structured questionnaire. Age in months, Sex, Socioeconomic Status, Occupational Status and Hemoglobin level, RBC Indices, Iron Profile were taken as a variables. The comparison was done between two groups through the Student's t-test for continuous variables and the chi-square test for the categorical variables by SPSS version 25. p-value < 0.05 considered as significant.

Results

The baseline characteristics of the two groups were similar (Table-I). Comparison of hematological parameters between two groups showing the decrease level of Hb, RBC, MCV, MCHC and increase RDW in the Case group, which was statistically significant when compares to the Control group. (Table-II).

A comparison of serum iron profile between two groups showing serum iron, serum ferritin and transferrin saturation (TSAT-Percentage of transferrin iron-binding capacity) was decreased except TIBC in the Case group, which was statistically significant when compares to the Control group (Table-III).

Association of IDA with Pneumonia where iron deficiency anemia was 65.6% in the Case group; 17.2% in the control group. Iron deficiency anemia was significantly higher in the Case group when compares to the Control group (Table-IV).

Table-I: Baseline characteristics between two groups (N=128)

Variables	Case (n=64) n (%)	Control (n=64) n (%)	p-Value
Age Mean ± SD (Months)	18.65±16.43	14.17±10.76	0.071^{ns}
Sex Male Female	 42 (65.6) 22 (34.4)	 47 (73.4) 17 (26.6)	0.922^{ns}
Socioeconomic Status Lower Class Middle Class Upper Class	 42 (65.6) 22 (34.4) 0 (0)	 47 (73.4) 17 (26.6) 0 (0)	0.334^{ns}
Occupational Status Businessman Service Housewife Others	 24 (37.5) 11 (17.2) 20 (31.3) 09 (14.1)	 27 (42.2) 09 (14.1) 15 (23.4) 13 (20.3)	0.611^{ns}

Table-II: Comparison of hematological parameters between two groups (n=128)

Complete blood count	Case (n=64) Mean ± SD Range (min-max)	Control (n=64) Mean ± SD Range (min-max)	p-value
Hb%	9.12±1.22 (6.89-11.89)	11.51±1.63 (9.56-13.79)	<0.001*
RBC count	4.34±0.67 (3.21-5.84)	4.93±0.57 (3.81-6.38)	<0.001*
MCV	65.36±9.26 (47.0-103.0)	81.25±11.23 (78.96-9.32)	<0.001*
MCHC	27.89±4.88 (13.0-36.81)	34.12±3.52 (25.0-46.12)	<0.001*
RDW (CV)	18.28±4.29 (7.21-29.18)	15.27±2.69 (11.89-24.82)	<0.001*

Table-III: Comparison of hematological parameters between two groups (n=128)

Serum iron profile	Case (n=64) Mean ± SD Range (min-max)	Control (n=64) Mean ± SD Range (min-max)	P-value
Serum iron	39.42±16.28 (14.1-84.47)	103.41±47.58 (11.98-115.6)	<0.001*
Serum ferritin	22.39±10.68 (2.98-35.2)	44.28±11.93 (12.36-57.63)	<0.001*
TIBC	426.21±74.39 (179.2-639.9)	301±77.69 (31.7-652.5)	<0.001*
TSAT	10.36±6.85 (3.63-42.18)	33.71±10.29 (3.45-53.82)	<0.001*

Table-IV: Comparison of hematological parameters between two groups (n=128)

Iron deficiency anemia	Case (n=64)		Control (n=64)		p-value
	n	%	n	%	
Present	42	65.6	11	17.2	<0.001*
Absent	22	34.4	53	82.8	
Total	64	100.0	64	100.0	

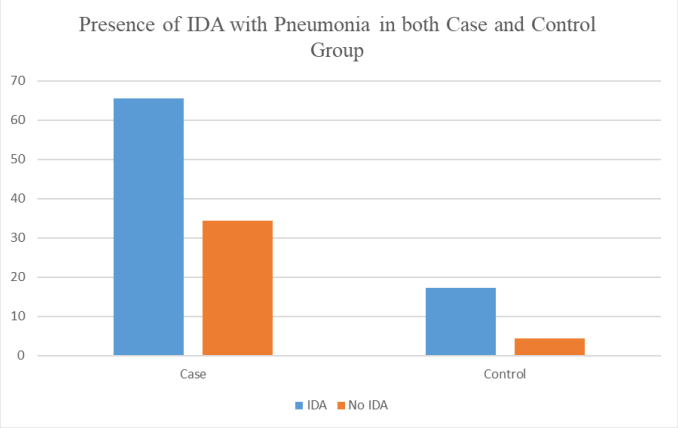

Figure-1: Bar diagram showing presence of IDA with Pneumonia in both case and control group.

Discussion

Pneumonia is one of the leading diseases threatening the health and lives of children, as the incidence and the mortality of pneumonia are significantly higher in childhood.

The mean age was 18.65±16.43 months in the case group and 14.17±10.76 months in the control group. The mean difference in age between groups was not statistically significant. A report was found where age ranged from 6-12 years and there was a non-significant difference between study and control groups (10.88±1.35 vs 10.81±1.49 years respectively). Besides, there was no significant difference between case and control groups as regards to weight, height or Body Mass Index (BMI) (19.24±1.57, 1.144±0.031 and 14.68±0.81 vs 19.56±1.34, 1.145±0.033 and 14.89±0.51, respectively) [7].

In the present study considering the socioeconomic status, a maximum of 65.6% and 73.4% of patients came from low-income socioeconomic status in cases and control respectively. No significant difference in socioeconomic status between the case and control group. Decrease of social class in the study group, when compared to the control group (22.7% 63.3, and 14.0% had a low, middle, and high social class in the study group; compared to 7.3, 79.3 and 13.3% in the control group respectively), were found in study[7].

Anemia is the commonest disease affecting human health and socio-economic development. The most common cause for anemia is nutritional deprivation, in particular, iron deficiency[8]. The prevalence of anemia varies between developed and developing countries. Reaching up to 50% of preschool children in some developing countries, ranging from 20-67% across several Arab Gulf countries and is principally caused by iron deficiency. As many as 20% of children in the United States and 80% of children in developing countries will be anemic at some point by the age of 18 years old[9].

The current study shows that anemia especially iron deficiency anemia is still a community problem in Bangladeshi children. Also, it provides a statistically significant positive association between anemia, predominantly iron deficiency anemia and chest infection particularly pneumonia.

In the present study, the prevalence of anemia was significantly higher among our patients (case) than in the control group were 42 (65.6%) of our patients (case) and 11 (17.2%) of the controls. The reported prevalence of anemia was significantly higher among cases than in the control group were 38 (76%) of cases and 22 (44%) of the controls were anemic and anemic children were about 4 times more susceptible to develop pneumonia than the non-anemic children[10]. WHO-2006 reported that in 2005, 60.3% of children from 6 months to 8.2 years of age had hemoglobin levels <11 gm/dl[11]. An author stated that low hemoglobin level is a risk factor for acute lower respiratory infections as it was detected in 62.5% of pneumonic patients, 56.25% of bronchiolitis cases and 42.71% of the control group with a p-value of 0.044[12]. Also, among Indian children, reported that 64.5% of their hospitalized patients and 28.2% of the healthy controls were anemic and that the anemic children were 4.6 times more susceptible to lower respiratory tract infection[13].

The mean hemoglobin level of our patients was 9.12±1.22 gm/dl which is significantly lower than that of the controls (11.51±1.63 gm/dl) (p-value: 0.001). These results agree with an author who found a significant difference between patients and controls regards the hemoglobin level with means of 9.5 ± 0.76 gm/dl and 11.3 ± 0.55 gm/dl respectively (p-value < 0.001)[14].

In the present study, iron deficiency anemia was 65.6% in the case of group 17.2% in the control group. Iron deficiency anemia was significantly higher in the case group compared to the control group. A reported iron deficiency anemia was the predominant type of anemia. It was detected in 24 (63.2 %) of the anemic patients and 12 (55%) of anemic controls[14]. Another author reported that iron deficiency was found in 78.9% of the anemic patients with a p-value < 0.01[13]. Also, another author found that the percentage of iron deficiency anemia in the anemic patients (48) was 75% and of the anemic controls (22) was 68.75%[15]. In agreement with the present study, another author showed anemia was significantly found in pneumonia patients and these patients were found to be 3.59 times more susceptible to pneumonia[16].

A study conducted in 2014 in Srinagar India found 64.5% of the cases anemic while only 28.2% of the controls were anemic[13]. While another study conducted in India found 74% of the cases anemic while only 33% of the controls were anemic[17]. A study conducted in Nepal found 68.6% of the cases having anemia while only 38.6% of the controls were having anemia[18]. Lebanese study found the prevalence of anemia was 32% in hospitalized cases and 16% in healthy controls. The mean hemoglobin level was 9.99± 0.62 gram per deciliter and 11.99 ± 0.92 gram per deciliter in the anemic and non-anemic group respectively with a significant p-value of 0.001[15].

In the present study, complete blood count showed that decrease level of Hb, RBC, MCV, MCHC and increase RDW in the case group, which was

statistically significant when compares to control. And iron profile as serum iron, serum ferritin, and transferrin saturation (TSAT) was decreased except TIBC in the case group. Another study reported similar findings[19]. By the present study, an author reported among the anemic children, 86% in the study group had iron deficiency. All the clinical parameters of anemia including hemoglobin, MCV, MCH, MCHC, RDW, serum iron, serum ferritin, and TIBC were found a statistically significant difference for ALRTI with P-value <0.01 when compares to the control group. Also noted the reason for low hemoglobin level was found to be a serious risk factor for developing pneumonia; where anemic children were found to be 4.99 times more susceptible to acute lower respiratory tract infection (ALRTI) compared to the non-ALRTI control group[20]. A study found that anemic children were 5.75 times more susceptible to ALRTI, which was consistent with our study[17]. Similarly, a study on modifiable risk factors for ALRTI and concluded that anemia was a significant risk factor for ALRTI[21-22]. Anemia was not found to be a risk factor for ALRTI in 512 infants and children below 5 years of age[23].

In the present study mean TIBC of the case group was 426.21±74.39 and the control group was 301±77.69. Mean TIBC was significantly higher in the case group compared to the control group. Another author found no significant difference concerning the total iron-binding capacity (TIBC) [10]. Our results came in agreement with an author who found that serum iron of the anemic cases (35.3 ± 14.4 mg/dl) was significantly lower than that of the anemic controls (57.1±13.8 mg/dl) with a P-value of 0.000[13].

In the present study showing serum iron, TIBC, serum ferritin, and transferrin saturation were significantly decreased in children with pneumonia. A reported in multivariate linear regression analysis, among the laboratory parameters, TIBC, serum iron, and serum transferrin saturation percentage were statistically significant predictors of iron deficiency in pneumonia cases[24].

The limitation was it's a single-center study, short duration of the study period, and the sample size was small. A large-scale study needs to be conducted to reach a definitive conclusion. All the children of 6 to 5 years of age with the risk of pneumonia should be screened for iron-deficiency anemia.

Conclusion

This study suggests that 65.6% of children of 6 months to 5 years of both sexes with pneumonia associated with iron deficiency anemia. So, iron deficiency anemic child more risk of developing pneumonia.

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