A COMBINATION OF HYPOALBUMINEMIA AND IRON DEFICIENCY ANEMIA AND ITS CONSEQUENCE IN PEDIATRIC PNEUMONIA

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ABSTRACT

Background:** In the pediatric population, pneumonia stands as the prevailing cause of mortality. The simultaneous presence of hypoalbuminemia and iron deficiency anemia presents specific difficulties in the treatment of pediatric pneumonia.* ***Objectives: *(1) To investigate the concurrent prevalence of hypoalbuminemia and iron deficiency anemia among children aged 2 months to under 5 years at Ca Mau Obstetrics and Pediatrics Hospital during the period of 2022-2023. (2) To assess the relationship between the hypoalbuminemia and iron deficiency anemia concurrence and pneumonia in children aged 2 months to under 5 years at Ca Mau Obstetrics and Pediatrics Hospital during the period of 2022-2023.* ***Materials and methods:*** *During the research period, 177 pediatric patients, ages 2 months to under 5 years, who were diagnosed with pneumonia and treated as inpatients at Ca Mau Obstetrics and Pediatrics Hospital, participated in a cross-sectional descriptive study. The determination of pneumonia was conducted in accordance with the WHO diagnostic criteria specifically established for children under the age of 5. Children presented with symptoms such as cough and/or dyspnea and/or fever, which were associated with fast respiration or chest indrawing. Tachypnea was assessed in relation to age as per WHO guidelines. Additionally, auscultation revealed small moist rales, whistling rales, or snoring rales in the lungs. Cardiopulmonary X-ray findings confirmed the diagnosis of pneumonia.* ***Results:*** *The proportion of male patients constituted 56.5%. The mean age was 22.5±15.82 months. The coexistence of hypoalbuminemia and iron deficiency anemia was found in 14.1% of cases. Children who had hypoalbuminemia and iron deficiency anemia were more likely to experience severe pneumonia, with a rate of 36% compared to 7.9% in the control group.* ***Conclusion:*** *The consequence of the simultaneous presence of both hypoalbuminemia and iron deficiency anemia is exacerbating pneumonia severity.*

Keywords: Pneumonia, hypoalbuminemia, iron deficiency anemia, children.

I. INTRODUCTION

Pneumonia remains a major cause of morbidity and mortality among young children worldwide [1], [2]. The simultaneous development of both iron deficiency anemia and hypoalbuminemia in pediatric pneumonia gives rise to numerous complications [3-5]. In the previous publication [6-7], we have provided data related to results from patients suffering from pneumonia when hypoalbuminemia and iron deficiency anemia were analyzed separately. In this article, we are going to present findings derived from the concurrent analysis of two variables pertaining to pediatric pneumonia among children below the age

of five, with a particular focus on the Ca Mau Obstetrics and Pediatrics hospital. This study aims to further clarify the potential impact of hypoalbuminemia in combination with iron deficiency anemia on pediatric pneumonia outcomes. The objectives of the study are (1) to investigate the concurrent prevalence of hypoalbuminemia and iron deficiency anemia among children with pneumonia aged 2 months to under 5 years at Ca Mau Obstetrics and Pediatrics Hospital during the period of 2022-2023 and (2) to assess the relationship between the hypoalbuminemia and iron deficiency anemia concurrence and pneumonia in children aged 2 months to under 5 years at Ca Mau Obstetrics and Pediatrics Hospital during the period of 2022-2023.

II. MATERIALS AND METHODS

2.1. Participants

Throughout the research period, all pediatric patients between the ages of 2 months and under 5 years given the diagnosis of pneumonia received admission to Ca Mau Obstetrics and Pediatrics Hospital.

- Patient Selection Criteria [8]

+ Children aged 2 months to under 5 years who were diagnosed with pneumonia were eligible for inclusion. The diagnosis of pneumonia was established according to the World Health Organization (WHO) criteria for children under 5 years of age.

+ Pneumonia was defined by the presence of cough and/or difficulty breathing, with or without fever, accompanied by at least one of the following clinical signs:

Age-specific tachypnea, defined by WHO as:

≥50 breaths per minute for children aged 2–12 months

≥40 breaths per minute for children aged 12–60 months

Chest wall retractions

+ Abnormal lung auscultation findings, including fine moist rales, wheezing (whistling rales), or coarse breath sounds (snoring rales).

+ In addition, chest radiography demonstrating findings consistent with pneumonia was used to support the diagnosis.

- Exclusion Criteria:

Children were excluded if they had any of the following conditions:

+ Diseases associated with hypoalbuminemia.

+ Chronic illnesses such as tuberculosis, chronic liver disease, chronic kidney disease, or nephrotic syndrome.

+ Congenital anomalies affecting the respiratory system, including bronchopulmonary dysplasia or pulmonary hypoplasia.

+ Other conditions known to contribute to anemia and/or reduced iron stores.

- Location and time of research: Investigation conducted within the respiratory department of Ca Mau Obstetrics and Pediatrics Hospital, spanning from November 2022 to May 2023.

2.2. Methods

- Research design: Analytical cross-sectional descriptive study.

- Sample size and sample selection:

The sample size was determined using a formula designed to estimate a proportion, employing the convenience sampling method.

$$n = Z^2_{(1-\alpha/2)} \ \frac{p(1-p)}{d^2}$$

n represents the minimum required research sample size; Z denotes the confidence coefficient at a 95% probability level (α=0.05), which corresponds to Z=1.96; d indicates the acceptable error and d=0.07 was used in this study. The variable p represents the proportion of patients with hypoalbuminemia among children in the study conducted by María Elena Álvarez Andrade et al. at Dr. Ángel Arturo Aballí Hospital, where p was recorded at 67.4% [9]. Therefore, a calculated sample size is 177 patients in our study.

- Research content:

+ Overview of the demographic attributes of participants: gender, age category, mean age.

+ Hypoalbuminemia: level of plasma albumin <37g/L;

+ Iron deficiency anemia: is evaluated by a combination of Hb concentration and other indicators of erythrocytes. 1. Level of age-adjusted Hb: less than 110g/dL for ages 6 months and older of participants; less than 10.3g/dL for ages 3-5 months
of those; less than Hb <9.4g/dL for 2 months of those; 2. There are three of five indicators of erythrocytes following: (1) Hypochromic anemia characterized by reduced red blood cell size as seen on a glass slide; (2) Mean Corpuscular Volume (MCV) less than 80 fL; (3) Red Cell Distribution Width (RDW) exceeding 14.5; (4) MCV relative to small red blood cells greater than 13.5; (5) Transferrin saturation below 15%.

+ The association between hypoalbuminemia and iron deficiency anemia and a background of pneumonia-related hospitalizations in the context of patient's pneumonia:

The data processing methodology employed involves the utilization of SPSS version 20.0 for statistical analysis.

- Ethical approval: The research was carried out in compliance with the Declaration of Helsinki and received approval from the Ethics Committee of Can Tho University of Medicine and Pharmacy for studies involving human participants (approval number: 22.122.HV/PCT.HDDD).

III. RESULTS

3.1. General characteristics of research subjects

Table 1. The general characteristics of research subjects

Characteristics		Frequency (n)	Percentage (%)
Age	2 months to <2 years	106	59.9
	2 - 5 years	71	40.1
	Mean	22.5 ± 15.82 months	
Gender	Male	100	56.5
	Female	77	43.5
Pneumonia severity classification	Pneumonia	156	88.1
	Severity pneumonia	21	11.9
Used antibiotics	≤1	165	93.2
	≥2	12	6.8

Characteristics		Frequency (n)	Percentage (%)
Pneumonia-related hospitalizations	Yes	38	21.5
	No	139	78.5

The percentage of patients within the 2 months to under 2 years age bracket stands at 59.9%, surpassing the 40.1% represented by the 2 years to 5 years age group. The mean age was 22.5 ± 15.82 months. The prevalence of pneumonia among female patients stands at 43.5%, while male patients account for 56.5% of cases. A significant proportion of pediatric patients diagnosed with pneumonia stands at 88.1%, while those classified as having severe pneumonia account for 11.9% of the total cases. Our research findings indicate that 6.8% of the subjects required the administration of two or more antibiotics for the treatment of pneumonia. The percentages of previous pneumonia-related hospitalizations were 21.5%.

3.2. The concurrent prevalence of hypoalbuminemia and iron deficiency anemia among children with pneumonia aged 2 months to under 5 years

The concurrent prevalence of hypoalbuminemia and iron deficiency anemia among children with pneumonia aged 2 months to under 5 years is 14.1% (25 patients).

Table 2. The prevalence of coexisting hypoalbuminemia and iron deficiency anemia among children aged 2 months to under 5 years, categorized by age and gender groups

Characteristic		Coexistence of both hypoalbuminemia and iron deficiency anemia		Total
		Yes	No	
		n (%)	n (%)	n (%)
Age group	2 months - <2 years old	7 (13.2)	46 (86.8)	53 (100)
	2 - 5 years old	18 (14.5)	106 (85.5)	124 (100)
Gender	Male	20 (20)	80 (80)	100 (100)
	Female	5 (6.5)	72 (93.5)	77 (100)

The prevalence of coexisting hypoalbuminemia and iron deficiency anemia is observed in 13.2% of children aged 2 months to 2 years, whereas this occurrence rises to 14.5% among children aged 2 to less than 5 years. The prevalence of iron deficiency anemia and hypoalbuminemia in the pediatric population is observed at 20% in males and 6.5% in females.

3.3. The relationship between the hypoalbuminemia and iron deficiency anemia concurrence and pneumonia disease among 2 month-5 year children

Table 3. The relationship involving the simultaneous presence of hypoalbuminemia, iron deficiency anemia, and a background of pneumonia-related hospitalizations

Coexistence of both hypoalbuminemia and iron deficiency anemia	Pneumonia-related hospitalizations		Total n (%)	p
	Yes n (%)	No n (%)		
Yes	4 (16)	21 (84)	25 (100)	0.472
No	34 (22.4)	118 (77.6)	139 (100)	

A prevalence of 16% was observed among children who had previously been hospitalized for pneumonia and were diagnosed with both iron deficiency anemia and hypoalbuminemia.

Table 4. The relationship between the severity of pneumonia and the co-occurrence of iron deficiency anemia and hypoalbuminemia

Coexistence of both hypoalbuminemia and iron deficiency anemia	The severity of pneumonia		Total n (%)	p
	Severe pneumonia n (%)	Pneumonia n (%)		
Yes	9 (36)	16 (64)	25 (100)	0.001
No	12 (7.9)	140 (92.1)	152 (100)	

Severe pneumonia was observed at a higher rate of 36% among children with coexistance of both hypoalbuminemia and iron deficiency anemia compared to 7.9% in the control group unaffected by these conditions.

IV. DISCUSSION

4.1. General characteristics of research subjects

According to our study, males have a higher prevalence of pneumonia in pediatric patients than females at 56.5%. The findings align closely with those of a 2017 study carried out at Saint Paul General Hospital by Nguyen Thi Hong Nhan and Nguyen Van Long, which reported a male representation of 56.94% and female representation of 43.06% [10]. Nguyen Duc Tri from Can Tho City Children's Hospital reported similar findings about 188 children hospitalized with pneumonia in 2019, where males made up 57.4% of the 108 cases and females made up 42.6% [11]. The 2020 study on community-acquired pneumonia in children, led by Nguyen Thi Ha, revealed that male children represented a larger proportion, accounting for 44.0%, compared to female children at 56.0% versus 44.0% [12]. The study's temporal aspect, sample selection methodology, and individual region's demographic attributes can all have a potential impact on this disparity.

The percentage of pediatric pneumonia patients aged between two months and two years in our study was 59.9%. The majority of this demographic was represented by this age group. The findings have a close connection to those reported by Álvarez A. M. E. and colleagues [9], who observed a rate of 69.7% in their study. In accordance with the research conducted by Nguyen Thi Ha et al., it has been observed that a significant proportion of children [12] suffering from community-acquired pneumonia are below the age of two. In contrast to the 47.3% reported in the research conducted by Nguyen Duc Tri and associates [11]. The average age of the participants in our study is 21.75 ± 15.59 months. The findings align closely with those reported by Nguyen Thi Hong Nhan et al., who observed an average age of 2.15 ± 1.92 years among their subjects. Notably, the majority of infants and toddlers diagnosed with pneumonia are under the age of 2 years [10]. This demographic exhibit heightened susceptibility to respiratory illnesses due to several contributing factors, such as the maturation of the child's immune system, close interactions with peers, and the common behavior of mouthing and sucking on various objects. Variations in rates observed in different studies can be attributed to factors such as the sampling methods utilized and the demographic characteristics of the corresponding geographic areas.

In our study, 21.5% of children with pneumonia had a history of hospitalization due to pneumonia. In author Nguyen Dinh Chung's study, the rate of children with a history of pneumonia is different from our study, which recorded the rate of first-time pneumonia and a history of 1 hospitalization due to pneumonia, history of 2 times of pneumonia, history of ≥3 times of pneumonia are respectively: 55.2%, 23%, 8.7%, 13.1% [13]. Research published

in 2021 by author Lumin Chen and colleagues, history of pneumonia in children is an independent risk factor for pneumonia, statistically significant in children <1 year old [4].

Our study revealed that 88.1% of the children were diagnosed with pneumonia, while 11.9% presented with severe pneumonia. The findings presented by Derek J Williams and his team align closely with our own, indicating a severe pneumonia rate of 7% [14].

4.2. The concurrent prevalence of hypoalbuminemia and iron deficiency anemia among children with pneumonia aged 2 months to under 5 years

25 children with pneumonia had iron deficiency anemia and hypoalbuminemia, accounting for 14.1%. In the group of children from 2 months - 2 years old, the proportion of children with iron deficiency anemia and hypoalbuminemia is 13.2%; in the group of children from 2 to under 5 years old, the proportion of children with iron deficiency anemia and hypoalbuminemia is accounting for 14.5%. However, the difference is not statistically significant (p>0.05). In the male children group, the rate of children with iron deficiency anemia and hypoalbuminemia is 20.0%, higher than in the female children group (6.5%). Author Nguyen Dinh Chung noted that the rate of iron deficiency anemia in the group of children with severe pneumonia was higher than that in the pneumonia group, so iron deficiency anemia could be a factor that aggravates the condition [13].

4.3. The relationship between the hypoalbuminemia and iron deficiency anemia concurrence and pneumonia in children aged 2 months to under 5 years

In our research, 36.8% of children hospitalized for pneumonia had hypoalbuminemia and iron deficiency anemia. 43.2% of children without pneumonia hospitalization had iron deficiency anemia. Difference is not statistically significant (p>0.05). According to a study by Nguyen Thi Hong Nhan (2017) on two case-control groups at Saint Paul General Hospital, the average frequency of pneumonia in anemic children (mainly iron deficiency anemia) was 4.12±2.15, higher than the group without anemia (0.75±0.38). Additionally, the frequency of hospitalization for pneumonia in anemic children (2.89±2.18) was higher than the group without anemia (0.76±0.72) [10].

Our research indicates that among children diagnosed with pneumonia and iron deficiency anemia, the incidence of severe pneumonia stands at 20.3%. This figure is notably elevated compared to the 5.8% observed in the cohort of children with pneumonia who do not have iron deficiency anemia. The observed difference is statistically significant, with a p-value of less than 0.05. Research indicates that children suffering from pneumonia often exhibit iron deficiency anemia, a condition that correlates with the severity of the pneumonia experienced. According to research results by author Nguyen Dinh Chung, children in the severe pneumonia group have a rate of iron deficiency anemia of 19.4%, higher than in the pneumonia group (14%). Our study's results, which were compiled by author Nguyen Dinh Chung, show a link between the severity of pneumonia in children and iron deficiency anemia. However, the statistical results show differences, which may be due to differences in sample size, location, and time period of the study [13].

Our study reveals that among children diagnosed with pneumonia and iron deficiency anemia, 58.1% experienced hospitalization for seven days or more. This figure surpasses the 41.7% observed in the cohort of children with pneumonia who do not have iron deficiency anemia. The observed difference is statistically significant, with a p-value of less than 0.05. The research conducted by Chisti MJ et al indicates that the mean duration of hospitalization for both anemic and non-anemic pediatric patients was 6 days [15]. Thus,

there is a statistically significant relationship between iron deficiency anemia and hospital stay for pneumonia treatment.

V. CONCLUSION

14.1% had both hypoalbuminemia and iron deficiency anemia. These conditions were more common in infants aged 2 months to 2 years old. The proportion of coexistence of both hypoalbuminemia and iron deficiency anemia was 20% in boys and 6.5% in girls. The presence of both hypoalbuminemia and iron deficiency anemia can worsen the severity of pneumonia and require a higher dosage of antibiotics for treatment. Our study's primary limitation is the absence of a healthy control group, which hinders definitively establishing anemia and hypoalbuminemia as causal risk factors versus associated conditions of pneumonia. Differentiating pre-existing states from illness-induced changes is thus challenging. Furthermore, uncontrolled confounders like nutritional status, immune function, and prematurity might influence our observed associations. Future research should incorporate prospective cohort designs with healthy controls to clarify causality. Additionally, exploring the complex interplay of nutrition, immunity, and other factors contributing to these conditions in pediatric pneumonia is crucial for informing targeted interventions.

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