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ABO Blood Groups and Haematological Parameters as Predictors of Pneumonia: A Study from Kosti Teaching Hospital, White Nile State, Sudan

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Abstract

Background

Pneumonia frequently represents the terminal illness leading to mortality in people with other serious, chronic diseases. About Each year, around 4 to 5 million people are diagnosed with pneumonia., and 55,000 of them die. In recent years, we've seen a worrying increase in respiratory diseases, including pneumonia. In November 2023, China's National Health Commission reported a rise in cases of several diseases, including influenza, coronavirus, and Mycoplasma pneumoniae, a bacterial infection that affects children. Pneumonia kills more children than any other disease – more than AIDS, malaria and measles combined. More than two million children die from pneumonia each year.

Methods

a case-control study conducted in White Nile State, Sudan to collect samples from Pneumonia patients from June 15 to August 2, 2024 at Kosti Teaching Hospital, a total of 100 study subjects

grouped into two groups (50 a case and 50 healthy controls) at Kosti Teaching Hospital were analyzed for blood indicators using the automated haematology analyzer (Sysmex KX21N) and the results were processed statistically using SPSS.

Results

The mean red blood cell count was slightly lower, while the mean hemoglobin level was slightly higher and the mean platelet count was slightly lower. Significant differences were noted in TWBC, LY Abs, M Abs, N Abs, lym%, M%, and Neut%. These differences suggest that the case group is probably showing signs of an active immune response, perhaps due to an infection or other inflammatory condition. Eosinophil and basophil numbers are not involved in differentiating pneumonia cases. The distribution of blood group prevalence showed association with the condition being studied in the cases, with some blood groups potentially being more or less susceptible. However, without further context about the study, these are merely observational patterns.

Conclusion

Low red blood cell count with high mean hemoglobin and low platelet count are potential, low-cost, and easily accessible indicators of disease severity in patients with pneumonia, as they can be derived from routine complete blood count measurements.

Keywords: Pneumonia; Haematological indice, ABO group, Kosti, Sudan.

1 - Introduction

Pneumonia is an infection of the small air sacs in the lungs (alveoli) and the tissues around them, and is one of the most common causes of death worldwide. Pneumonia frequently represents the terminal illness leading to mortality in people with other serious, chronic diseases. About Each year, around 4 to 5 million people are diagnosed with pneumonia. (not including pneumonia caused by COVID-19), and 55,000 of them die [1]. Data on the etiology of pneumonia are limited, and the information available is often difficult to interpret. Streptococcus pneumoniae is known to be the leading cause of severe pneumonia in children throughout the developing world. Bacteria also contribute to mild pneumonia, but to a lesser extent, and cases are likely to be of viral origin [2].

Another major cause is the bacterial pathogen Haemophilus influenzae type b (Hib). Other important pathogens include viruses, bacteria and less common fungi. However, more specific information on the etiology of pneumonia in children is lacking. Research is urgently needed to

better describe the distribution of pneumonia by cause. Knowing which pathogens because pneumonia is critical to guiding treatment and policy [3].

Pneumonia is a general term for inflammation of the lung tissue, Technically, pneumonia is a type of pneumonia because infections cause inflammation. However, doctors often use the term pneumonia to refer to noninfectious causes of pneumonia. Common causes of pneumonia include exposure to airborne irritants at work, at home, or through hobbies and recreation. In addition, some types of cancer treatments and dozens of medications can cause pneumonia. Difficulty breathing often accompanied by a dry (nonproductive) cough is the most common symptom of pneumonia. Specialized tests are needed to make a diagnosis. Treatment focuses on avoiding irritants and reducing inflammation. [4].

South Asia and sub-Saharan Africa together account for more than half of all pneumonia cases in children under five worldwide. Three-quarters of all pneumonia cases in children under five worldwide occur in just 15 countries [1]. Pneumonia is mainly caused by infections caused by bacteria or viruses and, to a lesser extent, fungi and parasites. Although more than 100 strains of infectious agents have been identified, only a few are responsible for most cases. Mixed infections caused by both viruses and bacteria may occur in up to 45% of infections in children and 15% of infections in adults. The causative agent may not be isolated in about half of cases despite careful testing [5].

Bacteria are the most common cause of community-acquired pneumonia, with Streptococcus pneumoniae isolated in about 50% of cases. Other common bacteria that can be isolated include Haemophilus influenzae in 20% of cases, Chlamydia pneumoniae in about 13% of cases, and Mycoplasma pneumoniae in about 3% of cases, as well as other species such as Staphylococcus aureus, Moraxella catarrhalis, Legionella pneumophila, and Gram-negative rods. A number of the above infections are drug-resistant and are becoming more common, including drug-resistant streptococcal pneumonia and methicillin-resistant Staphylococcus aureus [6, 7,8].

The spread of pathogens is facilitated by the presence of risk factors. Alcoholism is associated with Streptococcus pneumoniae, anaerobic organisms, and Mycobacterium tuberculosis; smoking facilitates the effect of Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, and Legionella pneumophila. Exposure to birds is associated with Chlamydia psittaci, farm animals with Coxiella burnetii, inhalation of gastric contents with anaerobic organisms, and cystic fibrosis with Pseudomonas aeruginosa and Staphylococcus aureus. Streptococcus pneumoniae is more

common in winter and should be expected in those who inhale large quantities of anaerobic organisms [9].

Viruses account for approximately one-third of the causes of pneumonia in adults and 15% of the causes of pneumonia in children. The most common viruses include rhinovirus, coronavirus, influenza virus, respiratory syncytial virus, adenovirus, and parainfluenza virus. Herpes simplex virus rarely causes pneumonia except in certain groups, such as newborns, cancer patients, organ transplant recipients, and people with severe burns [10]. People who have had organ transplants or who are immunocompromised are at high risk for developing CMV pneumonia. People with viral infections may develop secondary bacterial infections due to Streptococcus pneumoniae , Staphylococcus aureus , or Haemophilus influenzae , especially if they have other health problems. Different viruses predominate at different times of the year; for example, influenza viruses cause more than half of all viral infections during the flu season. Occasionally, outbreaks of other viruses, such as hantaviruses and coronaviruses, occur [11].

Fungal pneumonia is uncommon, but it is more common in people who have weakened immunity due to AIDS, immunosuppressive medications, or other health problems. It is most commonly caused by Histoplasma capsulatum (the cause of histoplasmosis), Blastomyces, Cryptococcus neoformans, Pneumocystis carinii, and Coccidioides immitis. Histoplasmosis is most common in the Mississippi Basin, and Coccidioidomycosis (or desert fever) is most common in the southwestern United States. The number of cases has been increasing in the latter half of the 20th century due to increased travel and decreased immunodeficiency in the population [1,12].

2- Diagnosis:

Pneumonia is usually diagnosed based on a combination of physical symptoms and a chest X-ray. However, confirming the causative agent can be difficult, as there is no definitive test that can differentiate between bacterial and non-bacterial causes. The World Health Organization has defined clinical pneumonia in children based on the presence of cough or difficulty breathing, rapid respiratory rate, chest inward retraction, or decreased level of consciousness. A rapid respiratory rate is defined as more than 60 breaths per minute in infants younger than 2 months of age, 50 breaths per minute in infants 2 months to 1 year of age, or 40 breaths per minute in children 1 to 5 years of age. A high respiratory rate and lower chest retraction in infants are more sensitive than auscultation of chest crackles [5].

In adults, medical tests are not needed for mild cases, as the risk of pneumonia is very low if all vital signs are normal and auscultation is normal. For people who require hospitalization, pulse

oximetry, chest x-ray, and blood tests — including a complete blood count, electrolytes, C-reactive protein, and liver function tests — are recommended if possible. The diagnosis of influenza-like symptoms can be based on signs and symptoms; however, confirmation of influenza requires testing. Therefore, treatment is often based on the presence of influenza in the community or a rapid influenza test [13].

In patients treated in the community, identification of the causative agent is not economically feasible and usually does not change the management of the case. In those who do not respond to treatment, sputum culture should be considered, and screening for Mycobacterium tuberculosis should be performed in those with chronic wet cough [14]. Screening for other specific organisms may be recommended during outbreaks and epidemics, for public health reasons. Sputum and blood cultures are recommended for seriously ill hospitalized patients, as well as urine testing for anti-legionella and anti-streptococci. Viral infections can be confirmed by detection of the virus or its antigens by culture or polymerase chain reaction, among other techniques. The causative agent is identified in only 15% of cases by routine microbiological examinations [15].

This study aims to address this gap by investigating the association between ABO blood groups, hematological parameters, and pneumonia among patients in Kosti Teaching Hospital, Sudan. By analyzing these relationships, we aim to provide insights into potential predictive markers that could inform clinical practice in resource-limited settings.

3 - Methods

This was a case-control study conducted at Kosti Teaching Hospital, White Nile State, Sudan, in 2024. The study aimed to assess hematological abnormalities, coagulation patterns, and ABO blood group associations in pneumonia patients. Ethical approval was obtained from the hospital's research ethics committee, and informed consent was collected from all participants prior to inclusion in the study.

The study included adult patients diagnosed with pneumonia based on clinical, laboratory, and radiological findings. Patients with comorbid conditions, such as hypertension and diabetes, were excluded to eliminate confounding factors. The inclusion criteria specified patients over the age of 18, presenting with symptoms of pneumonia. A total of 50 patients were enrolled, with their demographic and clinical characteristics recorded, including age, gender, and smoking status and and 50 apparently healthy volunteers as control group .

Data analysis was conducted using IBM SPSS statistics 21 . Descriptive statistics, including mean, standard deviation, and frequency distributions, were calculated for demographic and clinical

variables. The primary focus of the statistical analysis was to determine the differences in hematological parameters between pneumonia patients and the control group. Continuous variables were compared using independent t-tests . Categorical variables were compared using chi-square tests. A p-value of < 0.05 was considered statistically significant.

4 - Result:

General Characteristics of Participants

Table 1 presents the demographic and hematological data for pneumonia cases and controls. The mean age of cases (25.62 ± 12.19 years) was comparable to controls (24.70 ± 12.94 years), with no statistically significant difference. Total white blood cell count (TWBC) was significantly higher in cases (12.90 ± 6.02 × 10^3/μL) than controls (6.33 ± 1.36 × 10^3/μL, $p < 0.001$), indicating leukocytosis in pneumonia patients. Other parameters, such as red blood cell count (RBC), hemoglobin (HGB), and platelet count (PLT), did not show statistically significant differences between cases and controls.

White Blood Cell Subtypes

Table 2 compares the WBC subtypes between cases and controls. Absolute lymphocyte (LY Abs), monocyte (M Abs), and neutrophil (N Abs) counts were significantly higher in cases, with neutrophils showing the most pronounced increase (6.45 ± 2.54 vs. 5.42 ± 2.45 × 10^3/μL, $p = 0.045$). Conversely, the percentage of lymphocytes (lym%) and monocytes (M%) was lower in cases, reflecting a shift toward neutrophil predominance in pneumonia patients. No significant differences were observed for eosinophil (E Abs, E%) or basophil (B) levels, as these parameters were consistent across groups.

Red Blood Cell Indices

As shown in Table 3, RBC and hemoglobin levels were similar between cases and controls. However, mean corpuscular volume (MCV) was slightly lower in cases (76.66 ± 13.41 fL) compared to controls (82.29 ± 15.53 fL), suggesting a trend toward microcytosis, though not statistically significant. Hematocrit (HTC) levels were higher in cases (45.73 ± 8.98%) compared to controls (41.15 ± 4.68%, $p < 0.05$), potentially indicating a physiological response to hypoxia.

Platelet Indices

Table 4 shows that platelet count (PLT) was comparable between cases (291.02 ± 78.86 × 10^3/μL) and controls (297.32 ± 70.06 × 10^3/μL, $p > 0.05$). However, platelet distribution width (PDW) and mean platelet volume (MPV) were slightly lower in cases, suggesting potential changes in platelet activation or production.

Coagulation Profile

Table 5 presents the coagulation profile of participants. Prothrombin time (PT) and activated partial thromboplastin time (APTT) were significantly prolonged in cases compared to controls (p = 0.043 and p = 0.027, respectively). These findings may indicate an altered coagulation status in pneumonia patients, potentially linked to systemic inflammation.

ABO Blood Group Distribution

Table 6 outlines the ABO blood group frequencies among cases. Group O+ was the most prevalent (28%), followed by A+ (22%), B+ (20%), and O− (6%). No statistically significant association was observed between ABO blood groups and pneumonia status.

Table (1): Pneumonia cases and controls

Parameter	Participants	N	Mean	Std. Deviation	Std. Error Mean	P-value
Age	**Cases**	50	25.62	12.187	1.724	0.706
	Controls	50	24.70	12.937	1.830	
TWBC	**Cases**	50	12.898	6.0243	.8520	<0.001
	Controls	50	6.332	1.3595	.1923	
RBCS	**Cases**	50	4.6018	.83325	.11784	0.421
	Controls	50	4.7320	.67867	.09598	
HGB(g/dl)	**Cases**	50	13.720	5.6472	.7986	0.630
	Controls	50	13.200	2.1986	.3109	
PLT	**Cases**	50	291.02	78.858	11.152	0.682
	Controls	50	297.32	70.060	9.908	

Table (2)WBC subtypes between cases and controls

Parameter	Name	N	Mean	Std. Deviation	Std. Error Mean	P-value
TWBC	**Cases**	50	12.898	6.0243	.8520	<0.001
	Controls	50	6.332	1.3595	.1923	
LY Abs	**Cases**	50	5.386	4.6667	.6600	0.014
	Controls	50	3.306	1.4642	.2071	
M Abs	**Cases**	48	1.1917	.72665	.10488	<0.001
	Controls	50	.6490	.20159	.02851	
N Abs	**Cases**	48	6.446	2.5405	.3667	0.045
	Controls	50	5.416	2.4543	.3471	
lym%	**Cases**	50	28.724	13.7393	1.9430	0.002
	Controls	50	36.688	5.5776	.7888	
M%	**Cases**	50	6.592	4.6981	.6644	<0.001
	Controls	50	10.690	3.5793	.5062	
Neut%	**Cases**	50	71.458	15.9070	2.2496	<0.001
	Controls	50	54.648	12.1433	1.7173	
E Abs	**Cases**	50	1.00	.000[a]	.000	NaN
	Controls	50	1.00	.000[a]	.000	
E%	**Cases**	50	1.00	.000[a]	.000	NaN
	Controls	50	1.00	.000[a]	.000	
B	**Cases**	50	.00	.000[a]	.000	NaN
	Controls	50	.00	.000[a]	.000	

Table (3)RBC and hemoglobin levels

Group Statistics					
	Name	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
RBCS	**Cases**	50	4.6018	.83325	.11784
	Controls	50	4.7320	.67867	.09598
HGB(g/dl)	**Cases**	50	13.720	5.6472	.7986
	Controls	50	13.200	2.1986	.3109
HTC	**Cases**	50	45.7264	8.97742	1.26960
	Controls	50	41.1460	4.68180	.66211
MCV	**Cases**	50	76.662	13.4083	1.8962
	Controls	50	82.294	15.5260	2.1957
MCH	**Cases**	50	28.726	13.1274	1.8565
	Controls	50	28.478	10.5354	1.4899
MCHC	**Cases**	50	31.042	2.7502	.3889
	Controls	50	29.594	4.0038	.5662
RDW-CV	**Cases**	50	13.338	1.2385	.1751
	Controls	50	13.526	3.4242	.4842
RDW-SD	**Cases**	50	37.138	3.6446	.5154
	Controls	50	39.286	5.1595	.7297

Table (4): Platelet and its indices among participants

Group Statistics					
	Name	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
PLT	**Cases**	50	291.02	78.858	11.152
	Controls	50	297.32	70.060	9.908
MPV	**Cases**	50	9.136	1.4420	.2039
	Controls	50	9.664	2.3431	.3314
PDW	**Cases**	50	12.750	2.3363	.3304
	Controls	50	14.102	3.3599	.4752
PCT%	**Cases**	50	.26320	.064093	.009064
	Controls	50	.24452	.064519	.009124

Table (5): coagulation profile of participants

Group Statistics					
	Name	**N**	**Mean**	**Std. Deviation**	
PT	**Cases**	50	14.6316	1.52787	0.043
	Controls	49	13.7922	2.14849	
INR	**Cases**	50	1.31920	.164464	<0.001
	Controls	49	1.35188	2.170127	
RATIO	**Cases**	50	1.11776	.115886	<0.001
	Controls	48	1.69208	4.497727	
APTT	**Cases**	50	34.756	2.8288	0.027
	Controls	49	43.129	52.6018	

Table (6): ABO Group

ABO Group	Frequency	Percent
A-	1	2.0
A+	11	22.0
B-	1	2.0
B+	10	20.0
O-	3	6.0
o+	10	20.0
O+	14	28.0
Total	50	100.0

5 - Discussion:

This study investigated hematological abnormalities, coagulation patterns, and ABO blood group associations among pneumonia patients at Kosti Teaching Hospital, White Nile State, Sudan, in 2024. Pneumonia remains a significant health concern, ranking as the sixth leading cause of death globally and the primary cause of death from infectious diseases in developing countries [2]. Accurate early diagnosis, assessment of complications, and evaluation of disease severity are critical for effective management, influenced by clinical, laboratory, and radiological findings [4, 13]. The analysis of hematological abnormalities and coagulation patterns provides valuable insights into predicting disease severity and reducing treatment costs.

In this study, most participants were in their early twenties, but the large standard deviation suggests a rightward skew, with some older individuals increasing the mean age. Although the mean age aligns with findings from other studies reporting infections predominantly among individuals over 60 years [2, 3, 4], older age is often associated with more severe disease and worse clinical outcomes due to comorbidities. While comorbidities such as hypertension and diabetes were excluded in this study, their absence eliminated a confounding factor often linked to hematological changes [8, 12].

The study revealed significantly higher TWBC levels in pneumonia patients, consistent with previous research linking elevated TWBC with severe disease and mortality [4, 8, 13, 14]. However, the mean TWBC was not statistically significant, likely due to the limited sample size and study duration. Additionally, while the red blood cell count was slightly lower and hemoglobin levels were slightly higher, these results contrast with studies reporting significantly lower hemoglobin levels in severe cases [6]. Variability in red blood cell indices across studies highlights the need for further exploration [16]. Platelet counts were lower, aligning with findings in severe

cases of pneumonia [18]. Significant differences in TWBC, LY Abs, M Abs, N Abs, lym%, M%, and Neut% suggest an active immune response, reinforcing the potential of these indices as low-cost, accessible predictors of disease severity, particularly in resource-constrained settings [2, 17].

Eosinophil and basophil counts were not involved in differentiating pneumonia cases, corroborating previous findings [3, 8, 18]. ABO blood group analysis indicated O+ as the most prevalent, with A+ and B+ also common. Rare blood groups (AB+ and O-) were present, while A-, B-, and AB- were either very rare or absent. These patterns may hint at a relationship between blood group distribution and susceptibility to pneumonia, though further investigation is needed to draw definitive conclusions. These findings collectively provide a foundation for improving diagnostic and prognostic strategies in managing pneumonia.

6 - Conclusion

Low red blood cell counts, high mean hemoglobin levels, and low platelet counts emerged as potential, cost-effective predictors of disease severity, easily accessible through routine complete blood count measurements. Additionally, a significantly higher neutrophil count suggests a neutrophil-dominated immune response, consistent with bacterial infections or other inflammatory conditions, emphasizing its importance as a marker for disease severity.

The ABO blood group analysis indicated a predominance of O+, though further research is needed to explore potential susceptibility patterns.

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