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Impact of Nutritional Status and WBC Count on Outcomes in Childhood Acute Lymphoblastic Leukemia Therapy

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Abstract **Original Research Article**

Background: Acute lymphoblastic leukemia (ALL) is the most common childhood malignancy worldwide. Prognostic factors, including nutritional status and white blood cell (WBC) count at diagnosis influence treatment outcomes. Malnutrition weakens immune function, leading to infections and treatment delays, whereas hyperleukocytosis is associated with a poor prognosis. Understanding these factors is important for optimizing treatment strategies. This study aimed to evaluate the impact of nutritional status and white blood cell (WBC) count on treatment outcomes in childhood ALL. ***Methods:*** This cross-sectional study was conducted at the Department of Pediatric Hematology and Oncology, Bangabandhu Sheikh Mujib Medical University (BSMMU) from January to June 2013. Fifty children aged 1–15 years with newly diagnosed ALL, who received induction therapy, were included. Nutritional status was assessed using body mass index (BMI) (≥5 years) and weight-for-height (<5 years). WBC count was categorized as <50,000/mm³ and >50,000/mm³. Data were analyzed using SPSS, with statistical significance set at P <0.05. ***Results:*** Among the 50 patients, 62% were aged ≥5 years and 56% were male. Malnutrition was observed in 40% of the patients, and 66% had hyperleukocytosis (>50,000/mm³). Mortality was 100% among patients with WBC count >50,000/mm³. Malnourished children have prolonged neutropenia and higher infection rates with 10% mortality. Hyperleukocytosis was significantly associated with treatment failure and mortality (p<0.05). ***Conclusion:*** Nutritional status and WBC count were critical predictors of ALL treatment outcomes. Early nutritional interventions and risk-adapted treatment strategies can improve patient survival. A multidisciplinary approach is essential to improve patient outcomes.

Keywords: Acute lymphoblastic leukemia, nutritional status, white blood cell count, Hyperleukocytosis.

INTRODUCTION

Acute lymphoblastic leukemia (ALL) is the most frequent cancer in children, constituting nearly 25 percent of all pediatric cancers and more than 80 percent of childhood leukemia cases [1]. Treatment protocols have seen impressive advances; however, multiple prognostic factors influence outcomes, including initial WBC count and nutritional status at diagnosis [2]. Hyperleukocytosis, defined as WBC > 50 000/mm³, has been reported to be associated with an increased risk of induction failure, relapse, and mortality, contributing to tumor load and early complications of leukocytosis, metabolic derangements, and infections. Malnutrition is a significant problem in pediatric ALL patients, especially in developing countries, as it causes immunodeficiency, intolerance to chemotherapy and affects overall survival [5].

Treatment outcome in childhood ALL is related to nutritional status. However, malnourished children are also more poorly tolerant of treatment, have a higher rate of infection and show a prolonged neutropenia, with increased morbidity and mortality [6]. Although studies demonstrate that undernourished children are more prone to treatment related complications such as delayed hematologic recovery and to infections [7]. Additionally, malnutrition may cause treatment related toxicities to become more severe and extend length of therapy, and contribute to treatment delays and noncompliance [8]. Although less common in pediatric ALL, obesity has been reported to be associated with poor outcomes as

chemotherapeutic agent's pharmacokinetics can be changed and the risk for treatment related toxicity increased [9].

The role of hyperleukocytosis in pediatric ALL is well established as a poor prognostic factor. High WBC count at diagnosis is associated with an increased risk of CNS involvement as well as resistance to induction chemotherapy and both poor event free survival (EFS) and overall survival (OS). Dissemination due to the hyperleukocytosis, in particular, increases the patient's incidence of tumor lysis syndrome, disseminated intravascular coagulation, and severe infections, leading to worse outcomes [11]. High initial WBC counts have been identified as a marker indicating the need for intensified therapy, aiming to improve treatment response and survival outcomes in patients [12].

A comprehensive assessment at diagnosis is therefore necessary to consider independent and combined effects of nutritional status and WBC count on treatment outcomes and to risk stratify and individualize therapeutic interventions. Improving prognosis may involve addressing nutritional deficiencies through early nutritional support and optimizing chemotherapy regimens in patients with hyperleukocytosis. Previous research has identified these individual risk factors, but no study has quantified their combined effect on treatment outcomes in pediatric ALL patients from a resource limited care setting.

The purpose of this study was to assess the effects of nutritional status and WBC count on treatment outcome in childhood ALL. This study aims to gain insight into how to optimize therapeutic strategy and supportive care by analyzing their association with induction mortality, remission rates and treatment related complications in the pediatric ALL patients.

Objective

The objective of this study was to evaluate the impact of nutritional status and WBC count on outcomes in childhood acute lymphoblastic leukemia therapy.

METHODOLOGY & MATERIALS

This cross sectional study conducted at Department of Pediatric Hematology and Oncology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka from January 2013 to June 2013.

A total of 50 patients with acute lymphoblastic leukemia (ALL) aged between 1 and 15 years who received scheduled induction therapy were selected purposively and included in this study following the inclusion and exclusion criteria.

Inclusion Criteria:

1. Children aged 1–15 years diagnosed with acute lymphoblastic leukemia (ALL).
2. Receiving scheduled induction therapy.
3. Admitted for remission chemotherapy.
4. Provided written informed consent.

Exclusion Criteria:

1. Patients with severe comorbid conditions affecting treatment.
2. Patients who did not complete induction therapy.
3. Incomplete medical records or missing data.

Data collection: This study involved newly diagnosed children with ALL who fulfilled the eligibility requirements and were hospitalized for remission chemotherapy at the BSMMU Department of Pediatric Hematology and Oncology. Written informed consent was obtained from all the guardians. A pre-tested questionnaire was used to collect data on patient profiles, initial clinical manifestations, complications related to the disease and treatment, mortality causes, and rates. Patients underwent daily evaluations for any documented illnesses or issues.

Ethical considerations: The research was conducted after obtaining ethical approval from the authorities. Prior to the interview, written informed consent was obtained from the guardians of the participants. The consent form provided a clear explanation of the study's objectives and methodology, assured confidentiality of the interviews, outlined the potential risks and benefits of participation, and emphasized the voluntary nature of involvement, including the right to withdraw at any time without repercussions.

Statistical analysis of data: Statistical analyses were carried out by using the Statistical Package for Social Sciences version 16. Descriptive statistics were used to summarize patient demographics, nutritional status, and WBC counts. Chi-square and Fisher's exact tests were used to evaluate the relationships between variables. Continuous data were analyzed using independent t-tests. Statistical significance was set at $P < 0.05$. The results are presented as mean ± SD, frequency, and percentage to evaluate treatment outcomes.

RESULTS

Table 1: Distribution of the study patients by age (n=50)

Age (in years)	Number of patients	Percentage (%)
<5	19	38
≥5	31	62
Mean±SD	6.2±3.2	
Range	1-12	

Table 1 shows age distribution of the study patients, it was observed that 62.0% patients belonged to ≥5 year's age group. The mean age was found 6.2±3.2 years (range 1 to 12 years).

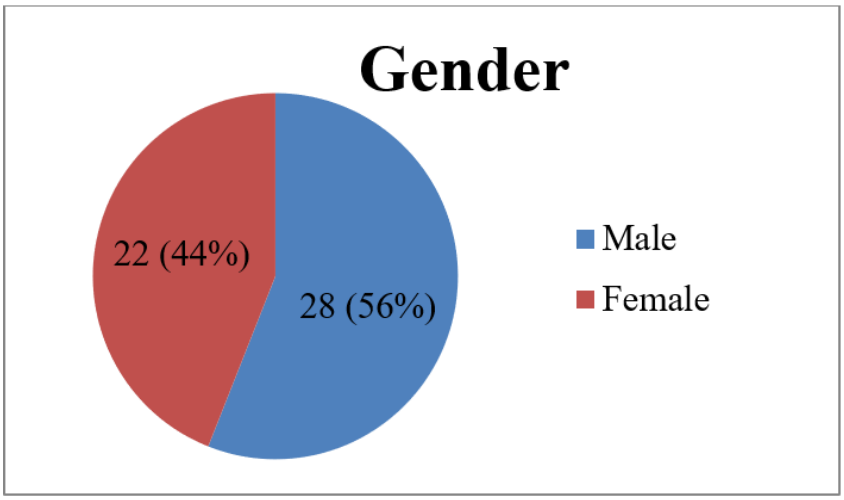

Figure 1: Distribution of the study patients by sex (n=50)

Figure 1 shows sex distribution of the study patients, it was observed that majority (56.0%) patients were male. The male: female ratio was 1.5:1.0.

Table 2: Nutritional status of the study patients (n=50)

Nutritional status		Frequency	Percentage (%)
≥5 years nutritional status assess by body mass index (BMI)	**Under nutrition <5th centile**	13	26
	Mild (-1 to -2)	1	2
	Moderate (<-2 to -3)	10	20
	Severe (<-3)	2	4
	Normal (5th – 85th centile)	18	36
	Over weight (>85th-95th centile)[14]	0	0
	Obesity (>95th centile)[14]	0	0
<5 years nutritional status assess by weight for height (SD)	**Under nutrition <5th centile**	7	14
	Mild (-1 to -2)	4	8
	Moderate(<-2 to -3)	2	4
	Severe(<-3)	1	2
	Normal (5th – 85th centile)	12	24
	Over weight(>85th-95th centile) [14]	0	0
	Obesity (>95th centile)[14]	0	0

Table 2 shows nutritional status of the study patients, it was observed that in 5 or more years age group 26.0% patients had under nutrition and in less than 5 years age group 14.0% patients had under nutrition.

Table 3: Association between nutritional status and mortality in childhood ALL (n=50)

Nutritional status	Number of patients	Mortality	Percentage (%)	p-value
Malnourished	20	5	25.0%	
Normal nutrition	30	1	3.33%	0.022

The associations between nutritional status and mortality are shown in this table. Among the 20 malnourished children, 10.0% died and 2.0% died from 30 patients with normal nutrition (p=0.022). These findings suggest that malnourished patients have a higher mortality rate.

Table 4: Distribution of the study patients by WBC count (n=50)

WBC count (mm^3)	Number of patients	Percentage (%)
<50000	17	34
>50000	33	66

Table 4 shows WBC count of the study patients, it was observed that, 66.0% patients had hyperleukocytosis (WBC>50000/mm^3).

Table 5: Association between WBC count and mortality (n=6)

WBC count (mm^3)	Number of patients	Percentage (%)
<50000	0	0
>50000	6	100

Table 5 shows that patients who expired, all had hyperleukocytosis (WBC count >50000 mm^3).

DISCUSSION

This study establishes an important relationship between patients' nutritional condition and White Blood Cell counts in shaping treatment results for pediatric patients with Acute Lymphoblastic Leukemia. The study demonstrated that children who presented with elevated white blood cell counts developed worse outcomes along with higher treatment failure and mortality rates, similar to Kong *et al.*, who stated that increased WBC counts at diagnosis, are a strong indicator of poor treatment results [10]. According to Prucker and colleagues, hyperleukocytosis creates both a higher risk for CNS involvement and resistance to induction therapy, which damages event-free survival prospects [11].

Treatment outcomes depended heavily on nutritional status among patients. According to research by Kumar *et al.*, malnourished children experienced more infections accompanied by longer periods of neutropenia and elevated treatment-related problems [12]. The research by Fadoo *et al.*, shows that insufficient nutrition in pediatric ALL patients create worse treatment results and elevated rates of morbidity from treatment [9].

The interaction of hyperleukocytosis together with malnutrition creates intense treatment obstacles. The research data reveals that children with concurrent conditions endured the most severe outcomes because early nutritional care combined with aggressive treatment of hyperleukocytosis remains essential. In a research paper Gupta *et al.*, demonstrated how mortality rates increase significantly for childhood ALL patients when they have multiple adverse prognostic factors [4]. The early intervention of nutritional deficiencies during treatment has been shown by Rubnitz *et al.*, to improve treatment associated tolerance [8].

Acute lymphoblastic leukemia-affected malnourished children showed elevated mortality statistics in comparison to well-fed children with leukemia according to our study. The research of Sonowal R and Gupta V demonstrated that undernourished patients with ALL faced increased treatment relapse rates and mortality because their bodies did not tolerate intensive cancer therapy well [13]. Our findings contribute to the growing body of evidence suggesting that nutritional status significantly impacts treatment outcomes in children with ALL.

Our results show that patients with WBC counts above 50,000/mm^3 experienced most mortality incidents during their induction treatment period. The study by Wheeler *et al.*, confirmed the increased risk of early patient death in those with extreme leukocytosis because of tumor lysis syndrome and sepsis complications [3]. Treatment-related toxicities require personalized therapeutic interventions when patients present with hyperleukocytosis at diagnosis according to Asim *et al.*, [5].

The relationship between WBC count and infection-related mortality has been thoroughly established in pediatric ALL studies. Hamidah *et al.*, noted that elevated leukocyte counts lead children to develop febrile neutropenia together with severe infections because both conditions damage the immune system and reduce blood cell counts [14]. High-risk pediatric leukemia patients experience a direct relationship between bacterial bloodstream infections and treatment complications according to Greenberg *et al.*, [15].

The findings from this study demonstrate how nutritional health, together with WBC count, determines the results of ALL treatment in childhood. The presence of hyperleukocytosis intensifies both treatment failure risk and death rates and malnutrition makes chemotherapy side effects worse and extends recovery

times. The improvement of survival outcomes in pediatric ALL depends on multidisciplinary planning that includes early nutritional intervention paired with high-risk patient management strategies. A combination of frequent nutritional evaluations with aggressive treatment methods shows potential to minimize malnutrition effects and hyperleukocytosis risks which results in better outlooks and health quality for children with these conditions.

LIMITATIONS AND RECOMMENDATIONS

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community. The findings require validation through larger multicenter research to discover the intricate relationship connecting nutrition status with WBC count in pediatric patients with ALL. Future studies need to determine how early nutritional therapy together with patient-specific therapies help reduce the negative effects of hyperleukocytosis.

CONCLUSION

The treatment results for childhood acute lymphoblastic leukemia depend largely on WBC count measurements and nutritional well-being. The combination of malnutrition and high leukocytes increases both treatment complications and mortality rates. The therapeutic success of initial dietary interventions along with tailored treatment strategies directly improves mortality rates. Treatment results and patient outcomes could be strengthened through combined nutritional support and detailed management of hyperleukocytosis as part of multidisciplinary care.

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Conflicts of interest: There are no conflicts of interest.

Ethical approval: The study was approved by the Institutional Ethics Committee.

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