Original Article

Patterns of Hematological Indices in Acute and Chronic Leukemia: A Hospital-Based Study

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Abstract

Background: Leukemia represents a heterogeneous group of hematological malignancies characterized by abnormal proliferation of white blood cells. It is broadly classified into acute and chronic forms, each exhibiting distinct clinical features and hematological profiles. Evaluation of hematological indices such as hemoglobin (Hb), total leukocyte count (TLC), platelet count, and red cell indices plays a crucial role in diagnosis, classification, and monitoring of leukemia. Understanding these patterns can aid in early detection and appropriate management. The aim and objective is to analyze and compare the patterns of hematological indices in patients diagnosed with acute and chronic leukemia in a hospital-based setting. **Material and Methods:** A 1-year hospital-based retrospective observational study was conducted at Saraswathi Institute of Medical Sciences, Pillhuwa, UP including 100 patients with acute (AML, ALL) and chronic leukemia (CML, CLL). Demographic and hematological parameters (CBC, differential counts, and red cell indices) were collected from records and analyzed using SPSS v25.0, with t-test/ANOVA and Chi-square test applied; $p<0.05$ was considered significant. **Results:** In 100 patients (50 acute, 50 chronic), acute leukemia occurred at a younger age (35.4 ± 18.2 vs 50.7 ± 14.6 years, $p<0.001$) with shorter disease duration. Hematologically, acute leukemia had lower hemoglobin, RBC, and platelets, higher RDW, and more blasts (all $p<0.001$) compared to chronic leukemia. Neutrophils were lower and lymphocytes higher in acute cases. **Conclusion:** Distinct patterns of hematological indices exist between acute and chronic leukemia. Acute leukemia is characterized by severe cytopenias and blast predominance, whereas chronic leukemia shows marked leukocytosis with relatively preserved hematological parameters. Routine hematological evaluation remains a valuable, cost-effective tool for the initial diagnosis and differentiation of leukemia types in clinical practice.

Keywords: Leukemia, Acute leukemia, Chronic leukemia, Hematological indices, Complete blood count, Peripheral smear.

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Introduction

Leukemia constitutes a diverse group of hematological malignancies characterized by uncontrolled proliferation of abnormal white blood cells in the bone marrow and peripheral blood. It is broadly classified into acute and chronic types based on the rate of disease progression and degree of cellular differentiation. Acute leukemias are aggressive and rapidly progressive, requiring immediate diagnosis and treatment, whereas chronic leukemias typically have a more indolent course and may remain asymptomatic for extended periods.[1] The global burden of leukemia continues to rise, with significant morbidity and mortality, particularly in developing countries where late presentation and limited diagnostic resources are common.[2] Hematological indices derived from routine complete blood count (CBC) testing serve as fundamental tools in the initial evaluation and diagnosis of leukemia. Parameters such as hemoglobin concentration, total leukocyte count (TLC), platelet count, and red cell indices including mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) provide valuable insights into the underlying disease process. These indices often exhibit characteristic patterns depending on the type and stage of leukemia, thereby aiding in early suspicion and differentiation between acute and chronic forms.[3] Acute leukemias, including acute lymphoblastic leukemia (ALL) and acute myeloid leukemia (AML), typically present with features of bone marrow failure. This results in anemia, thrombocytopenia, and neutropenia due to suppression of normal hematopoiesis by leukemic blasts. Patients often present clinically with fatigue, bleeding tendencies, and increased susceptibility to infections. Hematologically, peripheral blood smears frequently demonstrate circulating blast cells, which are a hallmark of acute leukemia.[4] In contrast, chronic leukemias such as chronic myeloid leukemia (CML) and chronic lymphocytic leukemia (CLL) are characterized by excessive proliferation of more mature and differentiated cells, leading to marked leukocytosis with relatively preserved hemoglobin levels and platelet counts, especially in early stages.[5] The evaluation of hematological indices not only facilitates diagnosis but also

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helps in disease classification, prognosis, and monitoring of therapeutic response. For instance, extreme leukocytosis is often observed in CML due to uncontrolled proliferation of myeloid cells, whereas lymphocytosis is a defining feature of CLL. Similarly, severe thrombocytopenia is more frequently associated with acute leukemias and may indicate a higher risk of bleeding complications.[6] Red cell indices, although less specific, can provide additional information regarding associated nutritional deficiencies or marrow involvement. In resource-limited settings, where advanced diagnostic modalities such as flow cytometry, cytogenetics, and molecular studies may not be readily available, reliance on basic hematological parameters becomes even more critical. Early identification of abnormal hematological patterns can prompt timely referral and further diagnostic workup, thereby improving patient outcomes.[7] Moreover, understanding these patterns can assist clinicians in distinguishing leukemia from other causes of cytopenias or leukocytosis, such as infections or reactive conditions. Several studies have highlighted the importance of correlating hematological indices with clinical and pathological findings in leukemia patients. Comparative analysis between acute and chronic leukemia reveals significant differences in hemoglobin levels, leukocyte counts, and platelet profiles, reflecting the underlying pathophysiological mechanisms.[8] These variations underscore the need for systematic evaluation of hematological parameters in suspected cases of leukemia. Despite advancements in diagnostic techniques, routine hematological investigations remain the cornerstone of initial assessment. They are cost-effective, widely available, and provide rapid results, making them indispensable in both urban and rural healthcare settings.[9] Furthermore, patterns observed in CBC parameters can guide clinicians in prioritizing further specialized investigations, thereby optimizing resource utilization. Therefore, the present hospital-based study aims to analyze and compare the patterns of hematological indices in patients with acute and chronic leukemia. By identifying characteristic differences in these parameters, the study seeks to contribute to improved diagnostic accuracy and better understanding of the hematological manifestations of leukemia.[10] To analyze and compare the patterns of hematological indices in patients diagnosed with acute and chronic leukemia in a hospital-based setting. To analyze and compare the patterns of hematological indices in patients diagnosed with acute and chronic leukemia in a hospital-based setting.

Materials and Methods

Study Design: Hospital-based retrospective observational study.
Study Place: Saraswathi Institute of Medical sciences Pillhuwa, Dist. Hapur UP
Study duration: 1 year.
Sample size: 100 patients with acute leukemia and chronic leukemia.
Study variables:

- Gender
- Age
- Hemoglobin
- Total Leukocyte Count
- Platelet Count (×
- Red Blood Cell Count
- Neutrophils
- Lymphocytes
- MCH
- Blasts
- MCV
- RDW
- MCHC
- Monocytes

Inclusion Criteria

- Patients of all age groups diagnosed with leukemia.
- Patients with acute leukemia (Acute Myeloid Leukemia [AML] and Acute Lymphoblastic Leukemia [ALL]).
- Patients with chronic leukemia (Chronic Myeloid Leukemia [CML] and Chronic Lymphocytic Leukemia [CLL]).
- Diagnosis confirmed by peripheral blood smear, bone marrow examination, and/or immunophenotyping.
- Patients who were admitted to the hospital during the study period.

Exclusion Criteria

- Patients with secondary or therapy-related leukemia.
- Patients with concurrent severe infections affecting hematological indices.
- Patients with incomplete or missing hematological records.
- Patients who refused consent (if applicable).
- Patients with other hematological disorders that could interfere with study parameters (e.g., aplastic anemia, myelodysplastic syndrome).

Statistical Analysis: Data were entered and analyzed using SPSS software version 25.0. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. Comparisons between groups were performed using Student's t-test or ANOVA for continuous variables and Chi-square test for categorical variables. A p-value <0.05 was considered statistically significant.

Results

Table 1: Demographic Characteristics of Patients

Characteristic	Acute Leukemia (n=50)	Chronic Leukemia (n=50)	Total (n=100)	p-value
Age (years, mean ± SD)	35.4 ± 18.2	50.7 ± 14.6	43.1 ± 18.1	<0.001
Gender (Male/Female)	28/22	32/18	60/40	0.42
Mean Duration of Illness (months)	3.5 ± 2.1	12.3 ± 6.7	7.9 ± 6.3	<0.001

Table 2: Complete Blood Count (CBC) Parameters

Parameter	Acute Leukemia (mean ± SD)	Chronic Leukemia (mean ± SD)	p-value
Hemoglobin (g/dL)	8.2 ± 1.6	10.5 ± 1.8	<0.001
Total Leukocyte Count (×10³/µL)	42.1 ± 28.5	75.3 ± 60.2	0.002
Platelet Count (×10³/µL)	65 ± 30	120 ± 55	<0.001
Red Blood Cell Count (×10⁶/µL)	3.2 ± 0.7	4.1 ± 0.8	<0.001

Table 3: Differential Leukocyte Count

Parameter	Acute Leukemia (%)	Chronic Leukemia (%)	p-value
Neutrophils	25.4 ± 15.2	55.3 ± 12.7	<0.001
Lymphocytes	65.1 ± 14.6	35.7 ± 10.8	<0.001
Monocytes	6.2 ± 3.5	7.8 ± 4.1	0.08
Blasts	35.3 ± 20.4	5.6 ± 3.2	<0.001

Table 4: Hematological Indices (MCV, MCH, MCHC, RDW)

Parameter	Acute Leukemia (mean ± SD)	Chronic Leukemia (mean ± SD)	p-value
MCV (fL)	88.5 ± 9.3	92.1 ± 7.8	0.04
MCH (pg)	28.3 ± 3.4	30.1 ± 3.1	0.02
MCHC (g/dL)	32.1 ± 1.8	32.7 ± 1.5	0.1
RDW (%)	17.4 ± 3.1	14.8 ± 2.7	<0.001

Table 5: Leukocyte Abnormalities

Feature	Acute Leukemia (n=50)	Chronic Leukemia (n=50)	p-value
Presence of Blasts (%)	45 (90%)	10 (20%)	<0.001
Dysplastic Neutrophils (%)	12 (24%)	20 (40%)	0.12
Anisocytosis (%)	38 (76%)	28 (56%)	0.04
Thrombocytopenia (%)	42 (84%)	18 (36%)	<0.001

Table 6: Correlation between Hematological Indices and Leukemia Type

Parameter	Correlation Coefficient (r)	p-value
Hemoglobin vs Leukemia Type	-0.52	<0.001
WBC vs Leukemia Type	0.46	0.001
Platelet Count vs Leukemia Type	-0.48	<0.001
RDW vs Leukemia Type	0.41	0.002

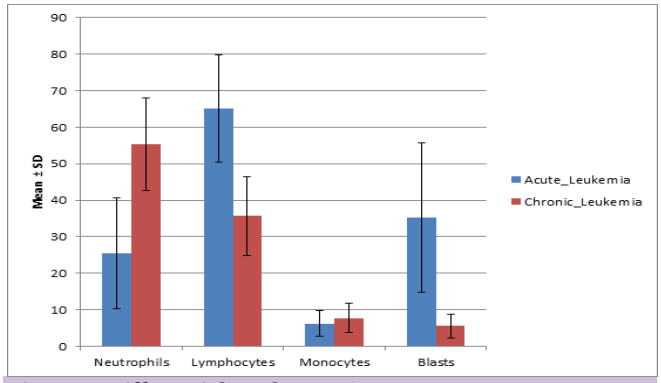

Figure 1: Differential Leukocyte Count

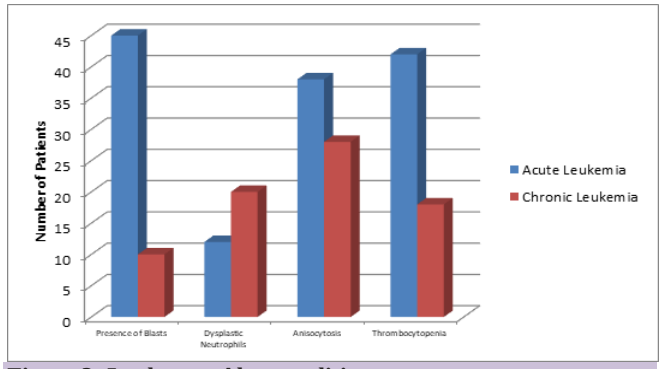

Figure 2: Leukocyte Abnormalities

Demographic Characteristics: The study included 100 patients, equally divided into acute leukemia (n=50) and chronic leukemia (n=50). The mean age of patients with acute leukemia was 35.4 ± 18.2 years, significantly lower than that of chronic leukemia patients (50.7 ± 14.6 years, p<0.001). The gender distribution was comparable between groups (male:female ratio 28:22 in acute vs 32:18 in chronic, p=0.42). The mean duration of illness was significantly shorter in acute leukemia (3.5 ± 2.1 months) compared to chronic leukemia (12.3 ± 6.7 months, p<0.001).

Interpretation: Acute leukemia predominantly affects younger individuals with a rapid onset, whereas chronic leukemia is more common in older patients with a prolonged disease course. Gender distribution did not differ significantly between the two types.

Complete Blood Count (CBC) Parameters: Acute leukemia patients demonstrated significantly lower hemoglobin levels (8.2 ± 1.6 g/dL) compared to chronic leukemia (10.5 ± 1.8 g/dL, p<0.001). Total leukocyte count was elevated in both groups but higher in chronic leukemia (75.3 ± 60.2 ×10³/µL) than in acute leukemia (42.1 ± 28.5 ×10³/µL, p=0.002). Platelet count was markedly reduced in acute leukemia (65 ± 30 ×10³/µL) versus chronic leukemia (120 ± 55 ×10³/µL, p<0.001). Red blood cell count was also significantly lower in acute leukemia (3.2 ± 0.7 ×10⁶/µL) compared to chronic leukemia (4.1 ± 0.8 ×10⁶/µL, p<0.001).

Interpretation: Acute leukemia is associated with more profound anemia and thrombocytopenia, reflecting the

aggressive marrow suppression typical of the disease. Chronic leukemia shows higher leukocyte proliferation, consistent with its slower but sustained disease progression.

Differential Leukocyte Count: Acute leukemia patients had lower neutrophil counts (25.4 ± 15.2%) and higher lymphocyte percentages (65.1 ± 14.6%) compared to chronic leukemia (neutrophils 55.3 ± 12.7%, lymphocytes 35.7 ± 10.8%; both $p<0.001$). Blasts were significantly more frequent in acute leukemia (35.3 ± 20.4%) than in chronic leukemia (5.6 ± 3.2%, $p<0.001$), while monocyte counts were similar ($p=0.08$).

Interpretation: The elevated blast count and lymphocyte predominance in acute leukemia reflect immature cell proliferation, whereas chronic leukemia is characterized by mature neutrophilic predominance and low blast percentage, indicating slower disease kinetics.

Hematological Indices (MCV, MCH, MCHC, RDW)

Acute leukemia patients exhibited slightly lower MCV and MCH values than chronic leukemia ($p=0.04$ and 0.02, respectively). RDW was significantly higher in acute leukemia (17.4 ± 3.1%) compared to chronic leukemia (14.8 ± 2.7%, $p<0.001$). MCHC did not differ significantly between groups ($p=0.10$).

Interpretation: Increased RDW in acute leukemia indicates greater anisocytosis and variability in red cell size, consistent with rapid marrow turnover and ineffective erythropoiesis.

Leukocyte Abnormalities

Blasts were present in 90% of acute leukemia patients versus 20% of chronic leukemia patients ($p<0.001$). Thrombocytopenia was observed in 84% of acute leukemia patients compared to 36% in chronic leukemia ($p<0.001$). Anisocytosis was more common in acute leukemia (76%) than in chronic leukemia (56%, $p=0.04$). Dysplastic neutrophils were slightly more frequent in chronic leukemia (40%) than in acute (24%), but this difference was not statistically significant ($p=0.12$).

Interpretation: The higher prevalence of blasts and thrombocytopenia in acute leukemia underscores its aggressive nature and marrow infiltration. Chronic leukemia patients show more subtle morphologic abnormalities reflecting slower disease progression.

Correlation Between Hematological Indices and Leukemia Type

Significant correlations were observed between hematological parameters and leukemia type. Hemoglobin and platelet count were negatively correlated with acute leukemia ($r = -0.52$ and -0.48, $p<0.001$), while WBC count and RDW showed positive correlations ($r = 0.46$, $p=0.001$; $r = 0.41$, $p=0.002$).

Interpretation: Lower hemoglobin and platelets are predictive of acute leukemia, whereas elevated WBC and RDW are indicative of disease activity and can help differentiate between acute and chronic leukemia.

Discussion

In this hospital-based study of 100 patients with leukemia, significant differences in demographic and hematological profiles were observed between acute and chronic leukemia subtypes. We found that patients with acute leukemia were significantly younger than those with chronic leukemia, consistent with reports indicating that acute leukemias, particularly acute lymphoblastic leukemia (ALL), peak in childhood and young adulthood, whereas chronic leukemias such as chronic lymphocytic leukemia (CLL) are more common in older adults.[11–13] The similar gender distribution across groups supports earlier epidemiological data showing a near-equal sex ratio in many leukemia cohorts.[14] Hematological parameters demonstrated distinct patterns between acute and chronic leukemia. Acute leukemia patients exhibited severe anemia and marked thrombocytopenia, reflective of profound bone marrow suppression by proliferating blasts and ineffective hematopoiesis. These findings align with previous studies reporting lower hemoglobin and platelet counts in acute leukemia due to marrow crowding and dysplasia.[15-17] In contrast, chronic leukemia patients showed higher leukocyte counts, characteristic of sustained clonal expansion of mature myeloid or lymphoid cells, particularly in chronic myeloid leukemia (CML) and CLL.[18] The differential leukocyte count further highlighted these contrasts. Acute leukemia was associated with elevated blast percentages and lymphocytosis, consistent with the accumulation of immature cells on peripheral smear—a hallmark diagnostic feature of acute leukemias. Conversely, the predominance of mature neutrophils in chronic leukemia reflects slower disease progression with relative preservation of maturation pathways. Monocyte counts did not differ significantly, suggesting that monocytic lineage involvement may be variable and subtype-dependent. Red cell indices showed statistically significant differences; RDW was higher in acute leukemia, indicating greater anisocytosis. Elevated RDW may reflect stress erythropoiesis and ineffective red cell production, which has been correlated with disease severity in acute leukemias. Although MCV and MCH differed marginally, the lack of significant change in MCHC suggests that hemoglobin concentration per cell remains relatively stable despite variations in cell size. Morphologic abnormalities such as presence of blasts, anisocytosis, and thrombocytopenia were more prevalent in acute leukemia, underscoring the aggressive marrow infiltration typical of these disorders. The high frequency of blasts supports their utility as a key diagnostic and prognostic marker.[19] Dysplastic neutrophils, though more common in chronic leukemia within our cohort, did not reach statistical significance, potentially due to the heterogeneity of dysplastic features across leukemia subtypes. Correlation analysis reinforced the diagnostic value of routine hematological indices: negative correlations of hemoglobin and platelet count with acute leukemia highlight their relevance as markers of marrow failure, while positive correlations of total leukocyte count and RDW with leukemia type emphasize their role in differentiating disease subgroups. These correlations are consistent with previous studies demonstrating that simple CBC parameters can be predictive of leukemia subtype and disease burden.[20] Overall, our findings corroborate existing literature on hematological profiles in leukemia and demonstrate the continuing relevance of basic hematological indices in diagnosis, subtype differentiation, and initial assessment of disease severity. Future studies with larger cohorts and integration of molecular markers could further refine these associations and improve prognostic stratification.

Conclusion

This hospital-based study demonstrates distinct hematological patterns between acute and chronic leukemia. Acute leukemia is characterized by younger age at onset, significant anemia, thrombocytopenia, elevated blasts, and higher RDW, reflecting aggressive marrow suppression and rapid disease progression. Chronic leukemia predominantly affects older patients, with higher leukocyte counts and more mature cell profiles, indicating slower disease kinetics. Routine hematological indices remain valuable for initial diagnosis, differentiation of leukemia subtypes, and assessment of disease severity.

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Conflicts of interest

There are no conflicts of interest.

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