ORIGINAL ARTICLE

SPECTRUM OF CHANGES IN HAEMATOLOGICAL PARAMETERS IN DIFFERENT LEUKEMIAS

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ABSTRACT

Objective: To determine the spectrum of changes in hematological parameters in Leukemia subtypes.

Materials and Methods: This descriptive cross-sectional study was conducted at Khyber Teaching Hospital in Peshawar from January 2024 to July 2024, after obtaining ethical approval from the Institutional Review and Ethical Board, using a non-probability purposive sampling technique. In this study, a total of 69 patients with acute and chronic leukemias were included. A Sysmex hematology analyzer was utilized to perform complete blood counts. The full blood count findings were recorded and analyzed using SPSS-23. The mean and standard deviation were applied to analyze quantitative variables, while qualitative data was examined as frequency and percentages.

Results: The average age of the study participants was 18 ± 13.94 years. The changes in blood counts included low hemoglobin levels in 68.5%, 82.35%, 100%, and 88% of ALL, AML, CLL, and CML cases, respectively, and a high TLC count in 60%, 41%, 62%, and 59% of ALL, AML, CLL, and CML cases, respectively. Thus, chronic leukemias have a higher incidence of low hemoglobin and high TLC counts compared to acute leukemias. There was a decrease in platelet count in 45.7%, 94%, and 62.5% of ALL, AML, and CLL cases, respectively, but an increase in platelet count in 88% of CML cases.

Conclusion: All leukemias are characterized by anemia, elevated white cell count, and thrombocytopenia, except chronic myeloid leukemia, which has elevated platelet counts. Complete blood count parameters provide sufficient information about the underlying leukemia subtype.

Keywords: Acute Lymphocytic leukemia, Acute Myeloid leukemia, Complete blood count, Chronic lymphocytic leukemia, Chronic myeloid leukemia.

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INTRODUCTION

Leukemia is a disorder characterized by the clonal proliferation of hematopoietic stem cells within the bone marrow. Primary care physicians most frequently encounter four main types: acute lymphoblastic, acute myelogenous, chronic lymphocytic, and chronic myelogenous leukemia. Acute lymphoblastic leukemia is seen more often in children, whereas the other forms are typically diagnosed in adults. [1]

In 2020, leukemia accounted for approximately 2.5% of all new cancer cases and 3.1% of all cancer-related deaths worldwide. [2] Acute myeloid leukemia (AML) represents about 1 in 3 leukemias in adults. However, AML is not common, making up about 1% of all cancers overall. [3] Chronic leukemia subtypes mainly affect adults. Upon diagnosis, chronic leukemia patients may not show any symptoms.

Approximately 50% of chronic lymphocytic leukemia (CLL) patients are diagnosed incidentally during routine blood tests that reveal lymphocytosis. [4] Similarly, many chronic myeloid leukemia (CML) patients are asymptomatic at diagnosis, with the disease often detected through abnormalities found on routine blood testing. [5] A complete blood count should be performed when leukemia is suspected. Chronic myelogenous leukemia and chronic lymphocytic leukemia are characterized by extremely high leukocytosis, often exceeding 100,000 white blood cells per µL (100.0 × 10^9 per L). In cases of chronic myelogenous leukemia, nearly 96% of patients have white blood cell counts over 20,000 per µL (20.0 x 10^9 per L), whereas only 34% to 38% of patients with acute myelogenous leukemia and acute lymphoblastic leukemia exhibit such elevated levels. [4,6,7] Acute leukemia may lead to low white blood cell counts along with anemia or low platelet counts. Additional initial laboratory tests for leukemia include bone marrow biopsy, flow cytometry, serum electrolytes, creatinine levels, liver function tests,

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and tests for blood clotting disorders. If the patient exhibits symptoms of illness or fever, the physician should investigate for infection through urinalysis, blood cultures, urine cultures, and chest X-rays. [1]

CBC parameters remain fundamental due to their cost-effectiveness, simplicity, and wide availability. Additionally, investigating the prognostic implications of CBC abnormalities may provide insights into disease progression, treatment response, and overall survival, thus guiding therapeutic decisions. The rationale for conducting this study is to determine the spectrum of hematological changes in different leukemias.

MATERIALS AND METHODS

This cross-sectional study was conducted at Khyber Teaching Hospital in Peshawar from January 2024 to July 2024 after obtaining ethical approval from the Institutional Review and Ethical Board using a non-probability purposive sampling technique. This study included 69 patients by using a proportion of 5.3%, 95% confidence interval, and 5% as the margin of error in Open EPI Software. Sample size estimation using OpenEpi is widely adopted in epidemiological research due to its user-friendly interface and robust statistical calculations. [8] This study included patients who were referred to the Pathology department with a suspicion of leukemia for bone marrow aspiration. The research excluded individuals undergoing chemotherapy for leukemia or those with inadequate aspirates for analysis. A Sysmex hematology analyzer was used to perform complete blood counts. Standard levels for TLC, Hb, and platelet count were 4 to 11 billion per cubic millimeter, 11.5 to 14 grams per deciliter, and 150 to 400 billion per cubic millimeter, respectively. All patients underwent a bone marrow aspiration and biopsy. Hematologists prepared and stained slides with Giemsa before examining them under a microscope. To differentiate between AML and ALL, slides were treated with myeloperoxidase stain for examination. Leukemia diagnoses were established based on this method. Variables analyzed included patient age, gender, leukemia subtype, and fundamental hematological parameters such as hemoglobin level, total leukocyte count, and platelet count. Data for these factors were documented in a standardized form and analyzed, and conclusions were drawn accordingly. The data was processed using SPSS software and primarily presented through tables and charts. Quantitative variables were assessed using the mean and standard deviation, whereas qualitative data was analyzed through frequencies and percentages.

RESULTS

The study included a total of 69 patients with acute and chronic leukemias. The mean age of our study is 18 ±13.94 years. About 32 (46.4%) cases were males and 37 (53.6%) cases were females. Acute lymphocytic leukemia percentage was highest among all other subtypes i.e., 50.7% as shown in Table 1. Absolute counts in leukemia are given in Table 2. Figures 1-3 display changes in hematological parameters observed in leukemia cases. Changes in blood counts were as low hemoglobin levels (in 68.5%, 82.35%, 100%, and 88% of ALL, AML, CLL, and CML cases respectively) and high TLC count (in 60%, 41%, 62% and 59% of ALL, AML, CLL and CML cases respectively). There was a decrease in platelet count (in 45.7%, 94%, and 62.5% of ALL, AML, and CLL cases respectively), but an increase in count in CML (in 88% of cases).

Table No 1: Demographic variables

Age	
	13.94 ± 18 (Mean ±S.D)
Gender	
Male	32 (46.4%)
Female	37 (53.6%)
Leukemia subtypes	
Acute Lymphocytic Leukemia	35 (50.7%)
Acute Myeloid Leukemia	17 (24.6%)
Chronic Lymphocytic Leukemia	8 (11.6%)
Chronic Myeloid Leukemia	9 (13%)

Table No 2: Absolute Count in Leukemias

Absolute Count (3 ^ 10cells/ μL)	Mean ± Standard Deviation	Range
Absolute Neutrophil count	90.71 ± 35.61	0.06-346.91
Absolute Lymphocyte Count	91.38 ± 39.14	0.75-470.66
Absolute Monocyte count	28.51 ± 9.15	0.00-220.62
Absolute Eosinophilic count	1.83 ± 0.84	0.00-7.53

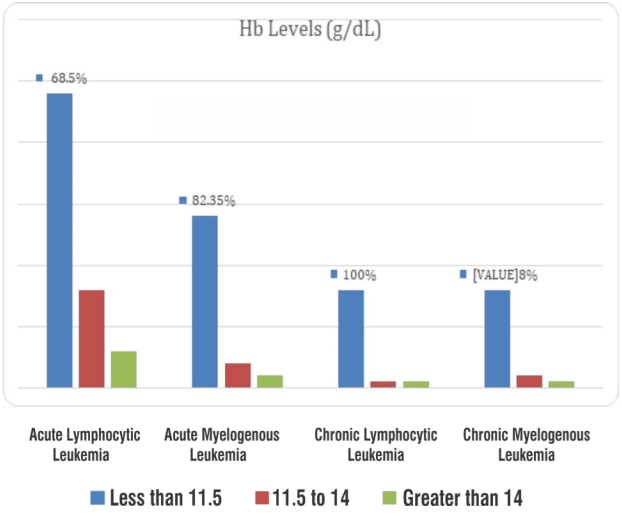

Fig 1: Pattern of Hb levels in different Leukemias

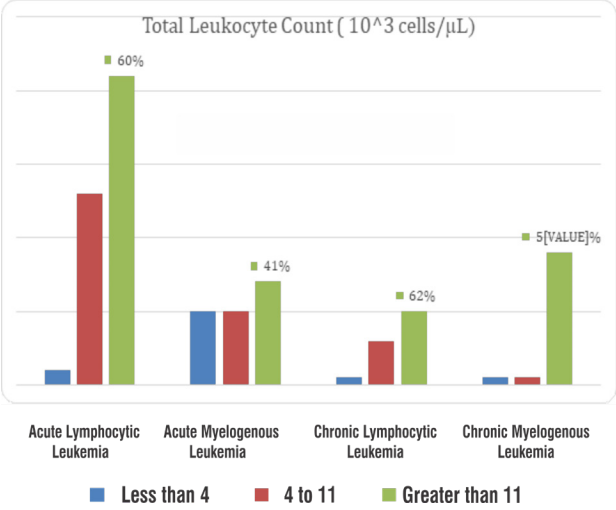

Fig 2: Pattern of Total Leukocyte Count in different Leukemias

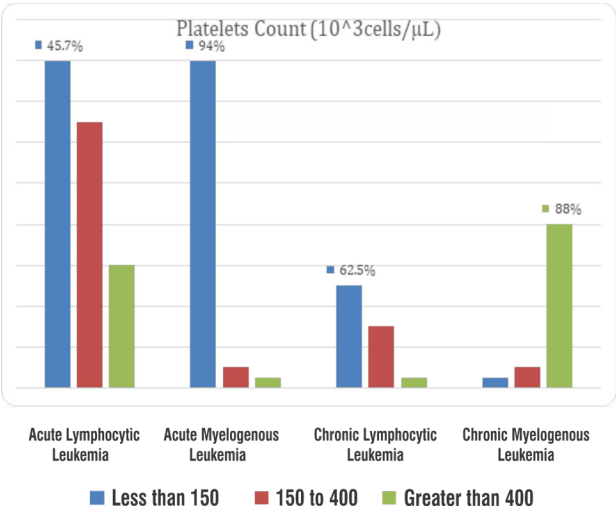

Fig 3: Pattern of Platelets count in different Leukemias

DISCUSSION

The presence of abnormal leukocytes distinguishes leukemia as either a primary or secondary condition. Various genetic and environmental factors contribute to the onset of leukemia. Increased rates of certain types of leukemia have been linked to exposure to ionizing radiation.

Previous chemotherapy treatments, especially those involving alkylating agents and topoisomerase II inhibitors, heighten the likelihood of acute leukemia in later years. [9, 10] The International Agency for Research on Cancer (IARC) classifies benzene as "carcinogenic to humans," based on sufficient evidence that it causes acute myeloid leukemia (AML). [11]

Viral infections like the human T-cell leukemia virus and Epstein-Barr virus have been associated with certain subtypes of ALL. [12] Additionally, genetic conditions (including Down syndrome, Fanconi anemia, Bloom syndrome, and Li-Fraumeni syndrome) are connected to higher susceptibility to AML and ALL. [13]

An initial test for patients suspected of leukemia is a complete blood count (CBC). This test reveals bone marrow changes caused by leukemic cells. The CBC results are distinctive enough that skilled physicians can identify a specific type of leukemia with confidence. [14] Recognizing abnormalities in CBC early allows for further confirmation tests such as bone marrow examination and flow cytometry. [15] Early detection facilitates prompt treatment, thereby lowering the risk of complications and death. In CBC, excessive aberrant leukocytes in the peripheral blood result in elevated TLC. [14, 15]

Malignant cells replacing marrow leads to diminished erythropoiesis, resulting in anemia or low Hb levels on CBC. [16] Anemia is a prominent characteristic in both acute and chronic forms of leukemia and carries prognostic significance. Thrombocytopenia, characterized by a low platelet count, can arise due to bone marrow infiltration by blast cells or splenomegaly, which is commonly observed across various types of leukemia. [17, 18] CBC findings in leukemias reflect the underlying pathogenetic mechanism.

The most frequent type of leukemia is acute lymphoid leukemia (ALL). In this study, ALL instances were characterized by elevated TLC, low Hb, and low platelets (60%, 68.5%, and 45.7%, respectively). This trend matches that reported in the literature. [16]

In a 2015 study involving ALL patients in Lahore, Naeem S reported elevated TLC in 58% of cases, low Hb levels in 74%, and low platelet counts in only 12% of cases; the remainder exhibited normal platelet counts. [19] In 2014, Moussavi F published similar findings from Iran, including anemia and thrombocytopenia in 89.7% of ALL patients. However, only an increased TLC was seen in 39% of cases. [16]

Perez JCJ reported similar findings from Spain in 2018. [15] The combination of elevated TLC, low Hb, and low platelet count should alert physicians to consider acute leukemia as a differential diagnosis. Infections can lead to anemia and increased TLC, but unlike acute leukemias, there is typically no decrease in platelet count. To ensure accurate diagnosis, all three hematological measures (TLC, Hb, and platelet count) should be evaluated.

CML is a myeloproliferative illness that primarily affects adults. The condition comprises three stages: chronic, accelerated, and blast crises. [17] In this study, basic hematological indicators showed increased TLC (59%) and decreased Hb (88%), similar to other types of leukemias. Surprisingly, there was an observed increase in platelet count instead of the anticipated decrease. In a 2017 study by Amer AH, 100% of CML patients had a higher TLC, 92%

had anemia, and 94.6% had a raised platelet count.

CBC abnormalities in CML include anemia, leukocytosis, and thrombocytosis (rather than thrombocytopenia). CML is a myeloproliferative condition, resulting in elevated platelet counts. So, all hematopoietic cells are growing, as are megakaryocytes. [17] CML has a higher platelet count compared to other leukemias, which often have lower counts. [17, 20] A specific CBC picture and clinical signs can help diagnose CML. Healthcare providers should take note of this particular discovery. CLL involves the malignant transformation of B-lymphocytes. Anemia is frequently encountered in CLL and holds prognostic significance due to its association with increased morbidity. Anemia in CLL can be caused by marrow infiltration, chronic illness, dietary deficits, or immune-mediated mechanisms. [20] The current study found a significant prevalence of anemia (100%) compared to Zeeshan's 26.7% and Dhodhi's 15.1%. [19, 20]

Salawuet et al. from Nigeria found a 74.4% incidence of anemia in CLL patients, similar to the current study. [21] Thrombocytopenia is a negative predictor of outcomes in CLL. In this research, 62.5% of CLL cases exhibited thrombocytopenia, a higher proportion compared to Zeeshan's 2015 study, where only 21.7% of CLL cases were reported to have low platelet counts. [20] A recent study conducted in Thailand found that approximately 19% of oral potentially malignant disorders (OPMDs) were positive for high-risk human papillomavirus (HPV) types 16 and 18, with HPV18 DNA predominantly detected in both oral leukoplakia and oral lichen planus patients. [22]

Most patients in our environment exhibit a bleak outlook, characterized by both anemia and thrombocytopenia, which signify advanced disease progression. [20] This suggests that our patients carry a substantial burden of illness, maybe due to late presentation to the clinician. CBC data can provide diagnostic clues when customized to a patient's history, age, and symptoms [14] Anemia and thrombocytopenia in CLL can predict the disease's prognosis. While further tests such as bone marrow biopsy and flow cytometry are employed to verify leukemia diagnoses, CBC results are as important and should not be overlooked.

As this study is conducted in a single tertiary care center, its results may not fully represent the entire population.

CONCLUSION

Knowledge of fundamental hematological parameters in leukemia, such as decreased hemoglobin and platelet counts alongside increased white blood cell counts (except in chronic myelogenous leukemia, where platelet counts are elevated), aids in refining differential diagnosis and identifying the specific leukemia subtype.

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Authors Contribution:

Following authors have made substantial contributions to the manuscript as under

Authors	Conceived & designed the analysis	Collected the data	Contributed data or analysis tools	Performed the analysis	Wrote the paper	Other contribution
Noor B	✓	×	✓	×	✓	×
Idrees M	✓	✓	×	✓	✓	×
Ahmad W	×	✓	×	×	✓	×
Khan A	✓	✓	✓	×	✓	✓
Ahmad H	✓	×	✓	×	✓	×
Khan LA	✓	✓	×	✓	✓	×

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical Approval:

This Manuscript was approved by the Ethical Review Board of Khyber Medical College, Peshawar. Vide No.337/DME/KMC. Dated: 29 04 2024