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DIAGNOSTIC AND PROGNOSTIC MARKERS OF LEUKEMIA DURING HEMATOLOGICAL ANALYZER EXAMINATION: LABORATORY ANALYSIS OF LEUKEMIA MARKERS

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U.Khatamova
Central Asian Medical University
Clinical residents,
U.Makhamatov
Fergana Medical Institute of Public Health

Abstract

This article analyzes the diagnostic and prognostic significance of laboratory markers obtained during routine examination using automated hematological analyzers in patients with leukemia. Changes in blood cell parameters, presence of blast cells, leukocyte differential counts, and analyzer flag systems are discussed. These laboratory markers play a crucial role in early diagnosis, disease stratification, prognosis assessment, and monitoring of treatment response in leukemia patients.

Keywords

leukemia, hematological analyzer, diagnostic markers, prognostic markers, blast cells, laboratory analysis.

Leukemia is a **malignant tumor disease of the blood and bone marrow**, in which white blood cells (leukocytes) proliferate uncontrollably and remain immature.[1,2,3,4]

In brief:

Abnormal white blood cells multiply rapidly in the bone marrow, They suppress the production of normal blood cells, As a result, the body becomes prone to infections, anemia, and bleeding.[5,6,7,8]

Causes of Leukemia

The exact cause of leukemia is not always known, but several risk factors have been identified:

Exposure to radiation, Chemical agents (e.g., benzene), Certain viral infections, Genetic predisposition, Patients who have undergone chemotherapy[9,10,11,12,13]

Main Symptoms of Leukemia

General Symptoms:

Persistent fatigue and weakness, Pale skin (due to anemia), Frequent infections, Fever, Weight loss[14,15]

Blood-Related Symptoms:

Nosebleeds or bleeding from the gums, Bruising (hematomas), Petechiae (small spots under the skin caused by bleeding)

Other Symptoms:

Bone and joint pain, Swollen lymph nodes, liver, and spleen

Types of Leukemia

Leukemia can be classified based on the course of the disease:

1.Acute Leukemia

Develops rapidly, Commonly occurs in children, Requires urgent treatment

2.**Chronic Leukemia**

Develops slowly, Mostly affects adults, Can be monitored over a long period

Leukemia can also be classified based on the type of affected cells:

- Lymphoblastic leukemia
- Myeloblastic leukemia

Introduction

Leukemia is a malignant disorder of the hematopoietic system characterized by uncontrolled proliferation of abnormal or immature white blood cells in the bone marrow and peripheral blood. This leads to suppression of normal hematopoiesis and results in anemia, thrombocytopenia, and immunodeficiency. Modern automated hematological analyzers have become essential tools for the early detection and monitoring of leukemia by providing rapid and reliable hematological parameters.

Role of Hematological Analyzers in Laboratory Diagnostics

Automated hematological analyzers perform complete blood count (CBC) analysis with high accuracy and efficiency. These systems classify blood cells based on cell size, granularity, internal complexity, and fluorescence characteristics. [16,17,18] As a result, abnormal cell populations typical of leukemia can be detected at an early stage.[19,20,21]

Diagnostic Markers of Leukemia Identified by Hematological Analyzers

1. White Blood Cell Count (WBC)

In leukemia patients, WBC count may show:

leukocytosis (marked increase), or

leukopenia (decrease), depending on the leukemia subtype and disease stage.[22,23,24]

2. Presence of Blast Cells

One of the most important diagnostic indicators of leukemia is:

detection of blast cell populations, appearance of analyzer flags such as **"Blast?"**, **"Immature Cells?"**, or **"Abnormal WBC Scattergram"**.

An increased percentage of blasts strongly suggests acute leukemia.[25,26,27]

3. Leukocyte Differential Count (DIFF)

Abnormalities in leukocyte differentiation include:

decreased neutrophils, increased lymphocytes or blast cells, presence of atypical or immature cells.[28,29,30]

These findings reflect disruption of normal hematopoiesis.

1. Erythrocyte and Platelet Parameters

Reduced hemoglobin (Hb) indicating anemia, decreased red blood cell (RBC) count, thrombocytopenia due to bone marrow infiltration.

These changes are typical laboratory features of leukemia.[31,32]

Prognostic Markers

1. Blast Cell Percentage

A high proportion of blast cells is associated with:

- aggressive disease course,
- unfavorable prognosis,
- increased risk of complications.

2. Platelet Count

Severe thrombocytopenia:

- increases bleeding risk,
- is considered a poor prognostic factor.

3. Extremely Elevated WBC Count

Marked leukocytosis may lead to:

hyperviscosity syndrome, leukostasis and organ dysfunction, which are associated with worse clinical outcomes.[33,34,35]

4. Analyzer Flag Systems

Automated flags such as:

"Suspected Leukemia", **"Abnormal Cell Distribution"**,

assist clinicians in identifying high-risk cases requiring urgent confirmatory testing.

Correlation with Additional Diagnostic Methods

Results obtained from hematological analyzers must be interpreted in combination with:

peripheral blood smear microscopy, bone marrow aspiration and biopsy, immunophenotyping by flow cytometry, cytogenetic and molecular studies.

This integrated approach ensures accurate diagnosis and classification of leukemia.[36,37]

Clinical Significance

Laboratory markers detected by hematological analyzers are essential for:

early detection of leukemia, risk stratification and prognosis evaluation, monitoring treatment response, detection of remission and relapse.[1,2,3]

Conclusion

Automated hematological analyzers serve as a valuable first-line diagnostic tool in leukemia. Key parameters such as WBC count, blast cells, analyzer flags, hemoglobin, and platelet levels provide important diagnostic and prognostic information. Comprehensive evaluation of these laboratory markers significantly improves early diagnosis and clinical management of leukemia patients.

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