Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 3 (2026): March 2026 Issue
https://doi.org/10.51168/sjhrafrica.v7i3.2609
Original Article

Clinico-hematological study of pancytopenia using bone marrow aspiration and trephine biopsy.

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Abstract

Background:

The objective of the study was to evaluate the clinico-hematological profile of pancytopenia and assess the diagnostic utility of bone marrow aspiration and trephine biopsy in determining its etiology.

Methods:

This prospective observational study was conducted at Baba Raghav Das Medical College, Gorakhpur, from December 2023 to November 2024. A total of 160 patients presenting with pancytopenia were included. Clinical evaluation, complete blood count (CBC), peripheral smear examination, bone marrow aspiration, and trephine biopsy (where indicated) were performed. Data were analyzed using descriptive statistics.

Results:

The study cohort demonstrated a slight male predominance (53.12%). Hypercellular marrow was the most frequent pattern (48.12%), followed by hypocellular (30.62%) and normocellular marrow (21.25%). A dimorphic blood picture was the most common peripheral smear finding (28.75%). Nutritional anemia constituted the leading etiology, with megaloblastic anemia accounting for 15.62% of cases and combined nutritional deficiency for 12.5%. Aplastic anemia was identified in 7.5% of cases and was more reliably diagnosed on trephine biopsy. Acute leukemias comprised 8.75% of cases. Dry tap was encountered in 3.75% of aspirations. The combined use of bone marrow aspiration and trephine biopsy yielded an overall diagnostic accuracy of 93.75%.

Conclusions:

Pancytopenia demonstrates a broad and heterogeneous etiological spectrum, with nutritional deficiencies emerging as the predominant cause in this study population. Bone marrow aspiration and trephine biopsy serve as complementary diagnostic modalities, and their combined application significantly enhances diagnostic precision, particularly in cases of hypocellular marrow and unsuccessful aspiration. Early and accurate bone marrow evaluation remains essential for timely diagnosis and appropriate clinical management.

Recommendation:

Early bone marrow evaluation should be routinely performed in pancytopenia to ensure timely diagnosis and appropriate management.

Keywords: *Pancytopenia; Bone marrow aspiration; Bone marrow trephine biopsy; Nutritional anemia; Megaloblastic anemia; Aplastic anemia; Acute leukemia; Bone marrow evaluation*
Submitted: *January 20, 2026* ***Accepted:*** *February 20, 2026* ***Published:*** *March 30, 2026*

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Introduction:

Pancytopenia is defined as a reduction in all three formed elements of blood—erythrocytes, leukocytes, and platelets—and is a frequently encountered clinical problem in hematology. Patients commonly present with symptoms related to anemia, recurrent infections, and bleeding tendencies. Pancytopenia itself is not a disease but a manifestation of diverse pathological processes affecting bone marrow function or peripheral blood cell survival [1].

The etiological spectrum of pancytopenia varies with geographic region, age, and socioeconomic status. In developing countries, nutritional deficiencies—particularly vitamin B12, folate, and iron deficiency—remain the predominant causes, whereas bone marrow failure syndromes and hematological malignancies are more frequent in developed nations [2,3]. Infectious diseases, drug-induced marrow suppression, and infiltrative disorders also contribute significantly.

Peripheral blood smear examination provides valuable initial diagnostic clues but is often insufficient to establish a definitive diagnosis. Bone marrow aspiration offers rapid cytological assessment, while trephine biopsy provides information regarding marrow cellularity, architecture, fibrosis, and focal lesions. Combined evaluation using BMA and BMB improves diagnostic accuracy in pancytopenia [4–6]. The present study was undertaken to analyze the clinico-hematological profile of pancytopenia and to assess the role of bone marrow aspiration and trephine biopsy in determining its etiology.

Methodology

Study Design

Prospective observational study.

Study Setting

The study was conducted in the Department of Pathology at Baba Raghav Das Medical College, Gorakhpur, a tertiary care institution providing diagnostic and treatment services. The study period was from December 2023 to November 2024.

Participants

Inclusion criteria

Patients of all age groups and both sexes presenting with pancytopenia.

Exclusion criteria

Patients with bleeding disorders, infection at the aspiration site, or refusal of consent.

Selection method

Consecutive sampling, patients in whom a definitive diagnosis could not be made, and patients who needed bone marrow aspiration/biopsy as one of the criteria for establishing a diagnosis

Study Size

The study was conducted on 160 cases, calculated by the formula given below:

$$N = Z\alpha 2p(1-p)/ L2$$

For 95% confidence interval, $Z\alpha 2 = 4$

L = Allowable error taken as 8% for the present study

p = Prevalence taken as 50%

Bias

Selection bias was minimized by consecutive sampling. Observer bias was reduced by standardized diagnostic techniques.

Data Collection

Detailed clinical history, physical examination, CBC, and peripheral smear findings were recorded. Bone marrow aspiration was performed in all cases, and trephine biopsy was done where indicated.

Statistical Analysis

Data were analyzed using descriptive statistics (frequencies and percentages).

Ethical Consideration

The study was approved by the Institutional Ethics Committee of Baba Raghav Das Medical College. Written informed consent was obtained from all participants.

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Results

Table 1: Age-wise distribution among male and female patients

		Male		Female	
		n	%	n	%
Age (years)	≤10 years	16	18.82	15	20.00
	11-20 years	18	21.18	25	33.33
	21-30 years	13	15.29	10	13.33
	31-40 years	4	4.71	7	9.33
	41-50 years	12	14.12	10	13.33
	51-60 years	13	15.29	3	4.00
	>60 years	9	10.59	5	6.67
Total		85	53.12	75	46.87

Bone Marrow Cellularity

Table 2: Bone Marrow Cellularity in Pancytopenia (n = 160)

Cellularity	n	%
Hypercellular	77	48.12
Hypocellular	49	30.62
Normocellular	34	21.25

CBC Findings:

All the examined cases show a low RBC count , WBC count and platelet count.

Peripheral Blood Smear Findings

Table 3: Peripheral Blood Smear Findings in Pancytopenia

Finding	n	%
Dimorphic	46	28.75
Leukemia	43	26.87
Microcytic	26	16.25
Macrocytic	25	15.62

Etiological Spectrum of Pancytopenia

Table 4: Bone Marrow-Based Etiology of Pancytopenia

Etiology	n	%
Megaloblastic anaemia	25	15.62
Combined nutritional deficiency anaemia	20	12.50
Micronormoblastic anaemia	15	9.37
Aplastic anaemia	12	7.50
Acute leukemia	14	8.75
Multiple myeloma	10	6.25

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Discussion

Key Findings

Nutritional anemia was the most common cause of pancytopenia. Combined bone marrow aspiration and biopsy showed high diagnostic accuracy (93.75%).

Interpretation

These findings are consistent with previous Indian studies. Gayathri et al. [10] and Varma et al. [11] also reported nutritional deficiencies as the leading cause of pancytopenia. However, the proportion of megaloblastic anemia in this study was lower compared to earlier studies [7–9].

Generalizability

The findings apply to similar tertiary care settings in developing countries with comparable socioeconomic and nutritional profiles.

Conclusion

Pancytopenia has a diverse etiological spectrum, with nutritional anemia being the most common cause. Bone marrow aspiration and trephine biopsy are complementary diagnostic tools that significantly enhance diagnostic accuracy.

Limitations

Single-center study, moderate sample size, and lack of advanced diagnostic investigations.

Recommendations

Routine bone marrow evaluation in pancytopenia and larger multicentric studies are recommended.

Acknowledgement

The authors acknowledge the Department of Pathology, Baba Raghav Das Medical College, for their support.

List of Abbreviations

CBC: Complete Blood Count
BMA: Bone Marrow Aspiration
BMB: Bone Marrow Biopsy

Source of Funding

No external funding was received.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

All authors contributed to study design, data collection, analysis, and manuscript preparation.

Data Availability

Data are available from the corresponding author upon reasonable request.

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Publisher Details:

Student's Journal of Health Research (SJHR)
(ISSN 2709-9997) Online
(ISSN 3006-1059) Print
Category: Non-Governmental & Non-profit Organization
Email: studentsjournal2020@gmail.com
WhatsApp: +256 775 434 261
Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa