

Original Research Article

Study on clinical and haematological profile of pancytopenia with special reference to bone marrow picture

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ABSTRACT

Background: Pancytopenia is a hematological condition characterized by the simultaneous reduction of red blood cells, white blood cells, and platelets. It represents a manifestation of various underlying disorders, ranging from nutritional deficiencies to hematological malignancies. Understanding the clinical and hematological profile, especially bone marrow morphology, is critical for diagnosis and management.

Methods: An observational study was conducted over 18 months at the Department of Medicine, K R Hospital, Mysuru, enrolling 35 adult patients diagnosed with pancytopenia. Detailed clinical history, physical examination, complete blood count, peripheral smear, serum vitamin B12 and folate levels, and bone marrow aspiration and biopsy were performed. Additional investigations were conducted as clinically indicated. Data were analyzed using appropriate statistical methods.

Results: The study population comprised 54.3% males and 45.7% females, with the majority aged between 31-40 years. The most common presenting symptom was easy fatigability (94.3%). Pallor was observed in all patients, with splenomegaly present in 51.4%. Hematological analysis revealed severe anemia, leukopenia, and thrombocytopenia. Peripheral smear predominantly showed macrocytic anemia (54.3%). Bone marrow examination revealed hypercellularity in 74.3% of cases. Megaloblastic anemia was the leading cause of pancytopenia (48.6%), followed by hypersplenism (14.3%) and aplastic anemia (11.4%).

Conclusions: Megaloblastic anemia due to vitamin B12 deficiency is the predominant cause of pancytopenia in this cohort, emphasizing the need for early nutritional assessment and intervention. Bone marrow evaluation remains a pivotal diagnostic tool, aiding in the identification of diverse etiologies and guiding appropriate management.

Keywords: Pancytopenia, Megaloblastic anemia, Bone marrow examination, Vitamin B12 deficiency, Hypersplenism

INTRODUCTION

Pancytopenia is a hematological condition characterized by the simultaneous reduction of all three major blood cell lines: red blood cells, white blood cells, and platelets.¹ This tri-lineage cytopenia reflects an underlying pathology affecting the bone marrow's ability to produce these cells or increased peripheral destruction or sequestration.² Pancytopenia is not a disease in itself but a clinical manifestation of a wide spectrum of disorders ranging

from benign and reversible conditions to life-threatening hematological malignancies.³ Understanding the clinical presentation and hematological profile of pancytopenia is crucial for timely diagnosis and appropriate management.

The bone marrow plays a central role in hematopoiesis, the process of blood cell production.⁴ Evaluating the bone marrow picture in patients with pancytopenia provides critical insights into the etiology of the condition.⁵ Bone marrow examination helps differentiate between marrow

failure syndromes, infiltrative diseases, megaloblastic anemia, aplastic anemia, leukemias, myelodysplastic syndromes, and infections such as tuberculosis or viral illnesses that may suppress marrow function.⁶ It also aids in identifying marrow fibrosis or infiltration by malignant cells. Therefore, correlating clinical features with hematological parameters and bone marrow morphology is essential for a comprehensive understanding of pancytopenia.

Clinically, patients with pancytopenia may present with symptoms related to anemia, such as fatigue, pallor, and dyspnea; infections due to neutropenia; and bleeding tendencies resulting from thrombocytopenia.⁷ The severity and combination of these symptoms often guide the urgency and direction of diagnostic workup. A detailed clinical history including exposure to toxins, drugs, nutritional status, presence of chronic illnesses, and family history is vital. Physical examination may reveal signs such as lymphadenopathy, hepatosplenomegaly, or petechiae, which can provide clues to underlying pathology.

Hematologically, pancytopenia is confirmed through complete blood count (CBC) showing decreased hemoglobin, leukocyte count, and platelet count.⁸ Peripheral blood smear examination may reveal morphological abnormalities such as anisopoikilocytosis, presence of immature cells, or dysplastic features.⁹ These findings, combined with bone marrow aspiration and biopsy, enable classification of pancytopenia into hypo-, hyper-, or normocellular marrow patterns, each associated with distinct etiologies.⁹ Hypocellular marrow typically suggests aplastic anemia or marrow suppression, whereas hypercellular marrow may indicate infiltration or ineffective hematopoiesis.

The etiological spectrum of pancytopenia varies geographically and is influenced by nutritional, infectious, environmental, and genetic factors.¹⁰ In developing countries, nutritional deficiencies such as vitamin B12 and folate deficiency are common causes, while in other settings, hematological malignancies and marrow aplasia predominate.¹¹ Infectious causes like malaria, leishmaniasis, and viral infections also contribute significantly. Drug-induced marrow suppression and autoimmune disorders are increasingly recognized as important contributors. Given the diverse causes and clinical implications, a systematic study focusing on the clinical and hematological profile of pancytopenia with a special emphasis on bone marrow findings is imperative.

Such a study will enhance understanding of the disease patterns, improve diagnostic accuracy, and guide therapeutic decisions. It will also help establish correlations between clinical presentation, laboratory parameters, and marrow morphology, facilitating early recognition of treatable causes and improving patient outcomes. This study aimed to comprehensively analyze patients presenting with pancytopenia, documenting their

clinical features, hematological parameters, and detailed bone marrow examination results. By doing so, it intends to delineate the common etiologies, identify characteristic marrow patterns, and correlate these findings with clinical presentations. The insights gained will contribute to better diagnostic algorithms and management protocols in clinical practice, ultimately advancing patient care in general medicine and hematology.

METHODS

The present observational study was conducted at the Department of Medicine, K R Hospital, Mysuru, Karnataka, over a period of 18 months from January 2019 to June 2020. A total of 35 adult patients diagnosed with pancytopenia were enrolled after obtaining informed written consent. Pancytopenia was defined by the presence of hemoglobin less than 10 g/dL, total leukocyte counts below 4000 cells/mm³, and platelet count less than 150,000 cells/mm³. The inclusion criteria for this study comprised adult patients diagnosed with pancytopenia. Additionally, only patients who provided informed written consent to participate were included. Patients on cytotoxic drugs, those receiving radiotherapy, known cases of immune thrombocytopenic purpura (ITP), individuals who had undergone blood transfusion within the preceding three months, and those who had taken vitamin supplements within three months were excluded from the study.

Detailed clinical history and physical examination were performed for all patients. Baseline investigations included complete blood count (CBC), peripheral blood smear examination, reticulocyte count, serum vitamin B12 and folic acid levels, malarial parasite testing, lactate dehydrogenase (LDH), liver function tests (LFT), thyroid function tests (TFT), chest X-ray, and abdominal ultrasonography. Bone marrow aspiration and biopsy were performed using Salah's and Jamshidi needles, respectively, under aseptic conditions. Special investigations such as upper gastrointestinal endoscopy, antinuclear antibody (ANA) profile, tuberculin test, and immunophenotyping were conducted when clinically indicated.

Ethical clearance was obtained from the Institutional Ethical Committee of Mysore Medical College and Research Institute, Mysuru. The study adhered to ethical standards, and all procedures were explained to patients prior to obtaining consent.

Data was analyzed using appropriate statistical methods. Frequency tables and proportions were computed, and results were expressed as means, standard deviations, frequencies, and percentages. The chi-square test was used for comparison of prevalence data, and Cramer's V test was employed to assess associations between categorical variables. The statistical analysis facilitated the evaluation of clinical profiles, hematological parameters, and bone marrow findings in patients presenting with pancytopenia.

RESULTS

Males constituted a slightly higher proportion of the study subjects, accounting for 54.3% (n=19), while females represented 45.7% (n=16).

Regarding age distribution, the largest proportion of participants belonged to the 31–40 years age group (25.7%, n=9), followed by the 18–30 years age group (22.9%, n=8). Participants aged 41–50 years and 61–70 years each constituted 14.3% (n=5) of the study population, while those aged 51–60 years accounted for 11.4% (n=4). Smaller proportions were observed in the 71–80 years age group (8.6%, n=3) and the 81–90 years age group (2.9%, n=1) (Table 1).

Among the presenting complaints, easy fatigability was the most common symptom, reported by 94.3% (n=33) of participants, followed by bleeding manifestations such as gum bleeding, melena, menorrhagia, epistaxis, and hematemesis, which were observed in 68.6% (n=24). Fever was reported by 34.3% (n=12) of participants, while palpitations and breathlessness were each present in 25.7% (n=9).

With respect to physical examination findings, pallor was observed in all participants (100%, n=35), indicating that anemia was a universal finding in the study population. Splenomegaly was the most frequent organomegaly, present in 51.4% (n=18), followed by hepatomegaly in 34.3% (n=12). Petechiae/purpura were noted in 25.7% (n=9) of participants, reflecting underlying thrombocytopenia or bleeding tendencies. Signs suggestive of cardiovascular involvement, including raised jugular venous pressure (JVP) and pedal edema, were each observed in 22.9% (n=8) of participants. Icterus was present in 14.3% (n=5) of cases (Table 2).

With regard to hemoglobin levels, nearly half of the participants (48.6%, n=17) had hemoglobin values between 5–8 g/dL, while 40.0% (n=14) had values between 1.8–5 g/dL, indicating severe anemia. Only 11.4% (n=4) had hemoglobin levels in the range of 8–10 g/dL. These findings demonstrate that the majority of

participants had markedly reduced hemoglobin concentrations. Analysis of the total leukocyte count revealed that 60.0% (n=21) of participants had counts between 1001–2500/mm³, followed by 28.6% (n=10) with counts between 2501–4000/mm³. A smaller proportion, 11.4% (n=4), had profound leukopenia with counts ranging from 500–1000/mm³. This indicates that leukopenia was a prominent hematological abnormality in the study population.

Regarding platelet counts, the majority of participants (68.6%, n=24) had platelet counts between 10,000–50,000/mm³, while 25.7% (n=9) had counts between 50,000–100,000/mm³. Severe thrombocytopenia with platelet counts of 2,000–10,000/mm³ was observed in 5.7% (n=2) of participants (Table 3).

On peripheral blood smear analysis, macrocytic morphology was the most common finding, observed in 54.3% (n=19) of participants. Normocytic blood picture was seen in 25.7% (n=9), while dimorphic anemia and microcytic morphology were noted in 11.4% (n=4) and 8.6% (n=3) of participants, respectively.

Assessment of bone marrow cellularity revealed that the majority of participants had a hypercellular marrow (74.3%, n=26), indicating increased hematopoietic activity. Hypocellular marrow was observed in 20.0% (n=7) of participants, whereas only 5.7% (n=2) exhibited normocellular marrow (Table 4).

Megaloblastic anemia was the most common cause, accounting for nearly half of all cases (48.6%, n=17). This was followed by hypersplenism in 14.3% (n=5) and aplastic anemia in 11.4% (n=4) of participants. Among the malignant causes, acute myeloid leukemia (AML) was identified in 5.7% (n=2) of cases, while metastatic malignancy, non-Hodgkin lymphoma, myelodysplastic syndrome, and myelofibrosis each contributed 2.9% (n=1) of cases. Autoimmune disorders such as Sjögren syndrome and systemic lupus erythematosus (SLE) were also observed in 2.9% (n=1) of participants each. Additionally, HIV infection was identified as the underlying etiology in one participant (2.9%) (Table 5).

Table 1: Distribution of study participants according to sex and age group (n=35).

Variables	Category	N	%
Sex	Male	19	54.3
	Female	16	45.7
Age group (in years)	18–30	8	22.9
	31–40	9	25.7
	41–50	5	14.3
	51–60	4	11.4
	61–70	5	14.3
	71–80	3	8.6
	81–90	1	2.9
Total		35	100

Table 2: Distribution of presenting complaints and physical findings among study participants.

Clinical feature	N	%
Presenting complaints		
Easy fatigability	33	94.3
Fever	12	34.3
Palpitations	9	25.7
Breathlessness	9	25.7
Bleeding manifestations (gum bleed, melena, menorrhagia, epistaxis, hematemesis)	24	68.6*
Physical findings		
Pallor	35	100
Splenomegaly	18	51.4
Hepatomegaly	12	34.3
Petechiae/Purpura	9	25.7
Raised JVP	8	22.9
Pedal edema	8	22.9
Icterus	5	14.3

*Combined bleeding manifestations; JVP - Jugular Venous Pressure

Table 3: Distribution of hematological parameters among study participants (n=35).

Hematological parameter	Category	N	%
Hemoglobin (g/dl)	1.8–5	14	40.0
	5–8	17	48.6
	8–10	4	11.4
Total leukocyte count (/mm³)	500–1000	4	11.4
	1001–2500	21	60.0
	2501–4000	10	28.6
Platelet count (/mm³)	2,000–10,000	2	5.7
	10,000–50,000	24	68.6
	50,000–100,000	9	25.7

Table 4: Distribution of peripheral blood smear findings and bone marrow cellularity among study participants (n=35).

Investigation finding	Category	N	%
Peripheral blood smear	Macrocytic	19	54.3
	Normocytic	9	25.7
	Dimorphic	4	11.4
	Microcytic	3	8.6
Bone marrow cellularity	Hypercellular	26	74.3
	Hypocellular	7	20.0
	Normocellular	2	5.7

Table 5: Distribution of etiological causes among study participants (n=35).

Etiology	N	%
Megaloblastic anemia	17	48.6
Hypersplenism	5	14.3
Aplastic anemia	4	11.4
Acute myeloid leukemia (AML)	2	5.7
Metastatic malignancy	1	2.9
Non-Hodgkin lymphoma	1	2.9
Sjögren syndrome	1	2.9
Systemic lupus erythematosus	1	2.9
HIV infection	1	2.9
Myelodysplastic syndrome	1	2.9

Continued.

Etiology	N	%
Myelofibrosis	1	2.9
Total	35	100

DISCUSSION

The present study analyzed 35 cases of pancytopenia admitted to K R Hospital, Mysuru, from January 2019 to June 2020, with an aim to evaluate the clinical presentation, hematological parameters, and bone marrow findings, and to compare these with previously published literature. Pancytopenia remains a common hematological problem worldwide, with diverse etiologies that vary regionally and demographically.

The age distribution in this study ranged from 19 to 81 years, which is consistent with the findings of Kumar et al, Tilak et al, Jha et al and other authors who reported similar age ranges in their respective cohorts.¹²⁻¹⁴ The male-to-female ratio of 1.18:1 observed here aligns with the male predominance reported by Kumar et al (2.1:1), Tilak et al (1.14:1) and others reaffirming the slight male preponderance in pancytopenic patients.^{12,13}

Clinically, easy fatigability was the most common presenting symptom in this study, reported by 94.28% of patients, which correlates well with the observations of Gayathri et al, Tilak et al and others authors all of whom documented fatigue as the predominant complaint.^{12,13} Fever was present in 34.28% of cases here, lower than the 43% reported by Jain et al possibly reflecting differences in underlying etiologies or patient populations.¹⁵ Other symptoms such as breathlessness, bleeding manifestations, and bone pain were less frequent but consistent with previous reports.

Physical examination revealed pallor in 100% of patients, consistent with findings from previous literature, highlighting anemia as a universal feature in pancytopenia.¹²⁻¹⁴ Splenomegaly was noted in 51.42% of cases, which is comparable to the rates reported by Tilak et al (50.6%), Gayathri et al (35.5%) and Khunger et al (32.5%), highlighting the frequent association of hypersplenism or infiltrative disorders with pancytopenia.^{13,16,17} Hepatomegaly was observed in 34.28% of patients, falling within the range reported by other studies.

The hematological profile showed a predominance of macrocytic anemia (54.29%) on peripheral smear, supporting the high incidence of megaloblastic anemia as the leading cause of pancytopenia in this cohort. Bone marrow examination revealed hypercellularity in 74.29% of cases, hypocellularity in 20%, and normocellularity in 5.71%, findings that are consistent with marrow responses in megaloblastic anemia and aplastic anemia as reported in prior studies.¹⁸ Etiologically, megaloblastic anemia accounted for 48.58% of pancytopenia cases, making it the

most common cause in this study. This aligns with findings by Gayathri et al, Khunger et al and Trivette et al who also reported megaloblastic anemia as the predominant etiology.¹⁶⁻¹⁸ Hypersplenism (14.29%), aplastic anemia (11.46%) and malignancies (11.4%) followed as significant causes, consistent with the etiological spectrum described by Kumar et al.¹⁹ The prominence of vitamin B12 deficiency leading to megaloblastic anemia highlights the importance of nutritional factors in this region.

Comparative analysis with Indian and international studies reveals regional variations in the etiology of pancytopenia. Indian studies predominantly report megaloblastic anemia and aplastic anemia as leading causes, while studies outside India, such as those by Imbert et al and Weinzierl et al report malignancies as more frequent etiologies.^{20,21} The present study's findings corroborate the Indian data, emphasizing the role of nutritional deficiencies and hypersplenism in this population.

Limitations

Limitations of this study include the relatively small sample size of 35 patients, which may restrict the generalizability of the findings to a wider population. The single-center design introduces potential selection bias and limits external validity. The observational nature of the study prevents establishing causal relationships between clinical features and etiologies. Additionally, advanced molecular or cytogenetic investigations were not performed, potentially limiting the depth of etiological analysis. Nutritional assessments focused primarily on vitamin B12 and folate levels, possibly overlooking other nutritional deficiencies or contributing factors. Furthermore, the absence of follow-up data on treatment outcomes and long-term prognosis limits understanding of the clinical course and effectiveness of interventions.

CONCLUSION

Pancytopenia is a commonly encountered hematological disorder with a diverse range of underlying etiologies. This study reinforces the importance of a thorough clinical evaluation combined with hematological investigations and bone marrow examination to accurately diagnose and manage pancytopenic patients. Megaloblastic anemia, predominantly due to vitamin B12 deficiency, emerged as the most frequent cause, highlighting the significant role of nutritional deficiencies in this region. Hypersplenism, aplastic anemia, and hematological malignancies were also notable contributors. Bone marrow examination proved invaluable in differentiating these causes by revealing characteristic marrow cellularity patterns. Early identification and treatment of reversible causes like

megaloblastic anemia can substantially improve patient outcomes and reduce morbidity associated with pancytopenia. Awareness of other etiologies ensures comprehensive patient care and guides appropriate therapeutic strategies.

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