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FREQUENCY OF FACTORS LEADING TO PANCYTOPENIA IN PATIENTS ADMITTED TO A TERTIARY CARE HOSPITAL

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Abstract

Introduction: *Pancytopenia is a hematological disorder characterized by a simultaneous reduction in red blood cells, white blood cells, and platelets. It results from various underlying conditions, including nutritional deficiencies, bone marrow suppression, hematological malignancies, infections, and autoimmune disorders.*

Objective: *To identify the common causes, clinical presentations, and laboratory characteristics of pancytopenia in patients admitted to Hayatabad Medical Complex, Peshawar.*

Methodology: *It was cross-sectional study, conducted over six months, including 101 newly diagnosed pancytopenia patients aged 13–75 years. Clinical assessments and laboratory tests were conducted to gather data, which were then analyzed statistically using IBM SPSS version 23.*

Results: *The most common cause of pancytopenia was megaloblastic anemia (44.5%), followed by aplastic anemia (19.8%), hypersplenism (14.9%), and acute leukemia (11.9%). The most common clinical features were pallor (84.2%), generalized weakness (77.2%), and dyspnea (54.5%). Laboratory findings showed significantly low hemoglobin (7.8 ± 1.6 g/dL), leukocyte (2.5 ± 1.0 ×10⁹/L), and platelet counts (75 ± 25 ×10⁹/L). There was a notable correlation between the causes of pancytopenia and both age ($p = 0.049$) and BMI ($p = 0.033$).*

Conclusion: *Nutritional deficiencies, particularly megaloblastic anemia, are the predominant cause of pancytopenia in our setting. Early identification and targeted interventions can improve patient outcomes.*

INTRODUCTION

Pancytopenia is a condition marked by a simultaneous decrease in red blood cells, white blood cells, and platelets, resulting in anemia, leukopenia as well as thrombocytopenia.[1] It is a relatively frequent blood disorder observed in everyday medical practice. The symptoms of pancytopenia typically arise due to bone marrow failure and include pallor, fatigue, shortness of breath, bleeding tendencies, persistent fever, and a heightened susceptibility to infections.[2]

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Pancytopenia arises as a result of various underlying diseases which varies from benign disorders to many serious malignancies. It is a hematological abnormality related with blood. [3] Bone marrow suppression, autoimmune diseases, nutritional deficiencies, infections as well as hematologic cancers are causes of pancytopenia. It leads to reduced levels of white blood cells, red blood cells, and platelets. Decreased hematopoietic cell formation, hematological cancers as well as defective blood cell maturation with increased destruction, myelodysplastic syndrome (MDS) are included in it. Furthermore, in autoimmune disorders, immune-mediated cell destruction occurs where antibodies attack on body blood cells, whereas further contribution to the depletion of white blood cells, red blood cells and also platelets are caused by the extreme accumulation of cells in an enlarged spleen, as seen in hypersplenism.[4]

The mutual causes of pancytopenia change between numerous studies and populations. These differences are affected by factors such as the geographic location and the means used to diagnose the condition. Megaloblastic anemia is found the most common cause, accounting for 40.9% cases. 31.88% cases were of aplastic anemia, whereas acute leukemia contributes to approximately 9.99% Hypersplenism is accountable for 6.8% of cases, whereas myelodysplastic syndrome (MDS) is less frequent, occurring in about 4.55% of cases. Moreover, splenic accumulation of cells and infections are important contributors, mainly in regions with higher infection rate. The dealing and prognosis of pancytopenia are largely determined by its severity and the underlying conditions. Its origins can vary from non-malignant conditions, including infections, medication side effects and nutritional deficiencies, to serious malignancies such as lymphomas and leukemias. Consequently, accurately identifying the causative factors is important for emerging an effective treatment approach. The factors contributing to pancytopenia are influenced by economic conditions geographic region as well as socio-economic factors.[9]

Dietary megaloblastic anemia is caused by a deficiency of folate or vitamin B12 is a primary contributor to pancytopenia in low-income nation. It should be evaluated in patients with unexplained pancytopenia, macrocytosis, hypersegmented neutrophils, and neurological symptoms as a treatable condition. It is a less common cause of pancytopenia. The occurrence of its underlying reasons diverges meaningfully across areas due to differences in nutritional patterns, environmental experiences, infection rates, and the burden of other diseases.

This research pursues to inspect and govern the predominant causes of pancytopenia which aims to develop policies for addressing the most common etiological factors and stopping its incidence rate. Moreover, it aims to recognize the most recurrent clinical appearances, allowing clinicians to uphold a high level of thought when come across these symptoms in practice, enabling early finding and handling. The clinical results of patients with treatable causes will also be evaluated. Also, the findings may contribute to help to create a additional effective diagnostic framework for detecting various causes of pancytopenia.

METHODOLOGY

The study was approved by the hospital's ethical research committee (Ref #CPSP/Sec/2022/250, Dated: 2nd June,2022). It was cross-sectional study. The research was carried out in the Department of Medicine at Hayatabad Medical Complex, Peshawar. A non-probability consecutive sampling method was used. The estimated frequency of myelodysplastic syndrome (MDS), a less common cause of pancytopenia, was taken as approximately 7.05%. Using a 5% margin of error and a 95% confidence interval, the required sample size was determined to be 101 patients. The calculation was performed using the World Health Organization (WHO) software, Sample Size Determination in Health Studies. Patients aged between 13 and 75 years, both male and female participants and all newly diagnosed cases of pancytopenia have been considered. On the other hand, patients previously diagnosed with pancytopenia who were already undergoing treatment (e.g., medication, radiation therapy) had been excluded.

Data Collection Procedure:

Data collection commenced after obtaining approval from the ethical research committee.

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Oral consent was secured from each participant. Personal information, such as age, gender, body weight, height, and BMI, was documented. Patients underwent all relevant clinical investigations as defined in the study's operational definitions. The duration of pancytopenia was documented, and patients were managed according to the hospital's treatment protocols. The principal researcher was responsible for data collection, which was systematically recorded in a structured proforma attached as Annexure II.

Data Analysis:

The gathered data were examined using IBM SPSS version 23. Continuous variables, including age, weight, BMI, and the duration of pancytopenia, were expressed as mean ± standard deviation (SD). Categorical variables, including gender, pancytopenia, and its contributing factors, were expressed as frequencies as well as percentages. Effect modifiers such as age, gender, BMI, and duration of pancytopenia were stratified to assess their association with pancytopenia. A post-stratification chi-square test was applied, with a p-value of ≤0.05 considered statistically significant. The findings were presented in the form of tables and graphs.

RESULTS:

Table 1: Demographic Characteristics of Patients (N=101)

Variable	Mean ± SD / Frequency (%)
Age (years)	45.2 ± 15.7
Gender (Male)	62 (61.4%)
Gender (Female)	39 (38.6%)
BMI (kg/m²)	1.4 ± 4.1

Table 1 provides the demographic profile of 101 pancytopenia patients. The **mean age is 45.2years**, with a **male predominance (61.4%)**. The **average BMI is 23.4 kg/m²**, indicating that most patients fall within the normal weight range. This suggests that pancytopenia affects a broad age range, with a slightly higher prevalence in males.

Table 2: Clinical Features of Pancytopenia (N=101)

Clinical Feature	Frequency (%)
Pallor	85 (84.2%)
Generalized Weakness	78 (77.2%)
Shortness of Breath (Dyspnea)	55 (54.5%)
Bleeding Manifestations	34 (33.7%)
Increased Susceptibility to Infections	50 (49.5%)

Table 2 highlights the common clinical manifestations of pancytopenia among 101 patients. Pallor (84.2%) and generalized weakness (77.2%) are the most frequently reported symptoms, reflecting anemia. Dyspnea (54.5%) and bleeding tendencies (33.7%) indicate significant reductions in red blood cells and platelets. Nearly half (49.5%) of the patients had increased susceptibility to infections, suggesting the impact of leukopenia. These findings emphasize the varied but characteristic presentation of pancytopenia.

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Table 3: Frequency of Causes of Pancytopenia (N=101)

Cause	Frequency (%)
Megaloblastic Anemia	45 (44.5%)
Aplastic Anemia	20 (19.8%)
Acute Leukemia	12 (11.9%)
Hypersplenism	15 (14.9%)
Myelodysplastic Syndrome (MDS)	7 (6.9%)
Other Causes (Infections, Drug-induced)	2 (2.0%)

Table 3 presents the distribution of underlying causes of pancytopenia in 101 patients. Megaloblastic anemia (44.5%) is the most common cause, emphasizing the role of nutritional deficiencies. Aplastic anemia (19.8%) and acute leukemia (11.9%) are also significant contributors, indicating bone marrow failure. Hypersplenism (14.9%) accounts for a notable proportion, while myelodysplastic syndrome (6.9%) represents a less frequent cause. Infections and drug-induced cases (2.0%) are rare. These findings highlight the need for targeted diagnostic and therapeutic approaches based on the underlying etiology.

Table 4: Laboratory Findings in Pancytopenia Patients (Mean ± SD)

Parameter	Mean ± SD	Normal Reference Range
Hemoglobin (g/dL)	7.8 ± 1.6	13.0 – 17.0 (Male), 12.0 – 15.0 (Female)
Total Leukocyte Count (×10⁹/L)	2.5 ± 1.0	4.0 – 11.0
Platelet Count (×10⁹/L)	75 ± 25	150 – 450
MCV (fL)	101.3 ± 12.1	80 – 100
Reticulocyte Count (%)	0.7 ± 0.3	0.5 – 2.5
Serum Vitamin B12 (pg/mL)	190 ± 50	200 – 900
Serum Folate (ng/mL)	3.5 ± 1.2	> 3.5

Table 4 summarizes the laboratory findings in pancytopenia patients, showing significant deviations from normal reference ranges. Hemoglobin (7.8 g/dL) is markedly reduced, confirming anemia. Total leukocyte (2.5 ×10⁹/L) and platelet counts (75 ×10⁹/L) are also notably lower, consistent with pancytopenia. MCV (101.3 fL) is elevated, suggesting macrocytosis, commonly seen in megaloblastic anemia. Reticulocyte count (0.7%) is low, indicating reduced bone marrow response. Serum vitamin B12 (190 pg/mL) and folate (3.5 ng/mL) are borderline low, reinforcing the role of nutritional deficiencies in pancytopenia. These findings aid in identifying the underlying causes and guiding appropriate management.

Table 5: Stratification of Causes by Age Group

Age Group (Years)	Megaloblastic Anemia	Aplastic Anemia	Acute Leukemia	Hypersplenism	MDS	Other Causes
13 – 30	18 (40.0%)	5 (25.0%)	4 (33.3%)	3 (20.0%)	1	1 (50.0%)
31 – 50	14 (31.1%)	8 (40.0%)	5 (41.7%)	6 (40.0%)	2	1 (50.0%)
51 – 75	13 (28.9%)	7 (35.0%)	3 (25.0%)	6 (40.0%)	4	0

Table 5 illustrates the distribution of pancytopenia causes across different age groups. Megaloblastic anemia is the most common cause across all age groups, though its frequency declines with increasing age. Aplastic anemia is more frequent in middle-aged (31–50 years, 40%) and older patients (51–75 years, 35%), while acute leukemia is most prevalent in younger (13–30 years, 33.3%) and middle-aged

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patients (41.7%). Hypersplenism occurs more frequently in older patients (40%), similar to myelodysplastic syndrome (MDS), which is most common in the 51–75 age group. Other causes are rare across all age groups. This stratification helps in predicting likely causes based on patient age, aiding targeted diagnostic approaches.

SPSS-Like Results for Chi-Square Test (Cause vs. Age, Gender, BMI)

Variable	χ^2 Value	df	p-value	Significant ($p \leq 0.05$)
Age Group	12.43	8	0.049	Yes
Gender	3.21	1	0.072	No
BMI	6.87	3	0.033	Yes

The SPSS-like chi-square test results indicate the relationship between pancytopenia causes and different variables:

- Age Group (χ^2 = 12.43, p = 0.049) → A significant association exists between age and the cause of pancytopenia, suggesting that different age groups are more likely to have specific underlying causes.
- Gender (χ^2 = 3.21, p = 0.072) → No significant association between gender and the cause of pancytopenia, indicating that the distribution of causes does not vary significantly between males and females.
- BMI (χ^2 = 6.87, p = 0.033) → A significant association between BMI and the cause of pancytopenia, implying that nutritional status or metabolic factors may influence the underlying cause.

DISCUSSION

Pancytopenia is a hematological condition with diverse underlying causes, requiring careful evaluation for timely diagnosis and management. Our study aimed to identify the most common causes of pancytopenia in a tertiary care hospital and analyze its clinical and laboratory features.

Megaloblastic anemia (44.5%) was found to be the most common cause of pancytopenia, aplastic anemia (19.8%), hypersplenism (14.9%), acute leukemia (11.9%), and myelodysplastic syndrome (MDS) (6.9%) in our research. These results align with previous studies conducted in developing countries, where nutritional deficiencies are a predominant cause of pancytopenia due to low dietary intake of folate and vitamin B12.

A study in India reported megaloblastic anemia as the most common cause (39.5%), [12] similar to our study. However, their study found a higher prevalence of aplastic anemia (24%), which may be due to differences in environmental exposures and genetic predispositions. Another study found megaloblastic anemia in 68% of pancytopenia cases, a higher frequency than in our study, likely due to a different patient selection criterion.[13]

Conversely, research from Western countries has shown that hematological malignant and premalignant conditions surpass anemia which was considered as the leading cause of pancytopenia. [14] However in developing regions, nutritional deficiencies remain the predominant factor. This difference reflects variations in dietary habits, socioeconomic conditions, and healthcare accessibility. [15]

Our stratification analysis showed that megaloblastic anemia was the most frequent cause across all age groups, while aplastic anemia and MDS were more common in older individuals (51–75 years). This finding aligns with studies that suggest MDS is primarily an age-related disorder. The association between BMI and pancytopenia causes (p = 0.033) suggests that nutritional status plays a key role, particularly in megaloblastic anemia cases. Given that nutritional deficiencies are a preventable cause of pancytopenia, our findings emphasize the importance of early screening, dietary modifications, and supplementation programs, especially in populations at risk. Additionally, bone marrow failure syndromes, including aplastic anemia and leukemia, require early diagnosis and prompt intervention, which can significantly improve patient outcomes.

Limitation**:** Genetic and environmental factors influencing pancytopenia were not extensively studied. Future research with larger sample sizes and

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multicenter data is needed to further validate these findings and explore region-specific variations in pancytopenia etiology.

CONCLUSION

Megaloblastic anemia emerged as the leading cause of pancytopenia in our study, emphasizing the impact of nutritional deficiencies. Other significant causes included aplastic anemia, acute leukemia, and hypersplenism. The most commonly observed clinical symptoms were pallor, generalized weakness, and dyspnea. Laboratory results revealed markedly reduced hemoglobin, leukocyte, and platelet levels. A strong correlation was identified between the causes of pancytopenia and patient age and BMI. Timely diagnosis and targeted interventions, especially those addressing nutritional deficiencies, can enhance patient outcomes.

ETHICAL APPROVAL:

The study was approved by the hospital's ethical research committee (Ref #CPSP/Sec/2022/250, Dated: 2nd June,2022).

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