

CLINICO-HEMATOLOGICAL PROFILE AND ETIOLOGICAL SPECTRUM OF PANCYTOPENIA IN ADULTS: A PROSPECTIVE OBSERVATIONAL STUDY AT A TERTIARY CARE CENTRE

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ABSTRACT

Background: Pancytopenia is characterized by a simultaneous reduction in erythrocytes, leukocytes, and platelets and may result from diverse nutritional, infectious, hematological, and systemic disorders. The etiological spectrum varies across geographical regions and clinical settings. This study aimed to evaluate the clinico-hematological profile and determine the etiological spectrum of pancytopenia among adults presenting to a tertiary care hospital. **Materials and Methods:** This hospital-based prospective observational study included 120 consecutive adult patients aged ≥ 18 years fulfilling predefined hematological criteria for pancytopenia. Detailed demographic and clinical characteristics were recorded. Hematological evaluation included complete blood count, red-cell indices, absolute neutrophil count, reticulocyte count, and peripheral blood smear. Biochemical, nutritional, infectious, autoimmune, and radiological investigations were performed according to clinical indications. Bone marrow aspiration and/or trephine biopsy was undertaken when clinically indicated. Etiology was established by integrating clinical and laboratory findings. Associations between clinical/hematological parameters and major etiological categories were assessed using appropriate statistical tests, with $p < 0.05$ considered significant. **Result:** Of 120 patients, 57.5% were males and 48.3% were aged 18–40 years. Generalized weakness/fatigue (75.8%) and fever (60.8%) were the commonest symptoms, while pallor (93.3%) was the predominant clinical finding. Nutritional disorders were the leading etiological category (31.7%), followed by hematological malignancies/clonal disorders (18.3%), bone marrow failure disorders (16.7%), infections (15.0%), and hypersplenism/chronic liver disease (10.8%). Macrocytosis and hypersegmented neutrophils were significantly associated with nutritional etiologies ($p = 0.0040$ and $p < 0.0001$, respectively), whereas circulating blasts were strongly associated with hematological malignancies ($p < 0.0001$). Bone marrow examination was performed in 68 (56.7%) patients, with hypercellularity being the commonest pattern (44.1%). **Conclusion:** Adult pancytopenia has a heterogeneous etiological spectrum, with potentially reversible nutritional disorders forming an important proportion. Systematic clinical and hematological evaluation, supplemented by targeted bone marrow examination, facilitates timely etiological diagnosis and appropriate management.

INTRODUCTION

Pancytopenia is a clinico-hematological condition characterized by a simultaneous reduction in all three major cellular components of peripheral blood—erythrocytes, leukocytes, and platelets.^[1] It is not a disease in itself but a manifestation of a heterogeneous group of disorders ranging from potentially reversible nutritional deficiencies and infections to bone marrow failure syndromes,

myelodysplastic syndromes, and hematological malignancies.^[2,3] Clinically, patients may present with manifestations attributable to anemia, leukopenia, and thrombocytopenia, including fatigue, dyspnea, fever, recurrent infections, and bleeding.^[4]

The pathogenesis of pancytopenia broadly involves impaired production of hematopoietic cells, ineffective hematopoiesis, marrow replacement or infiltration, and accelerated peripheral destruction or

sequestration of blood cells.^[1,5] Consequently, systematic evaluation using clinical history and examination, complete blood count, reticulocyte count, peripheral blood smear, and targeted biochemical, microbiological, and radiological investigations is essential. Bone marrow aspiration and/or trephine biopsy provides additional diagnostic information when marrow failure, dysplasia, infiltration, or hematological malignancy is suspected or when the etiology remains unexplained.^[2,5]

The etiological spectrum of pancytopenia varies considerably according to geographical region, nutritional status, infectious disease burden, referral patterns, and characteristics of the population studied. Indian studies have frequently identified megaloblastic/nutritional anemia, aplastic anemia, infections, and hematological malignancies among the important causes, although their relative frequencies vary substantially between centres.^[3,6,7] Since several causes are reversible when recognized early, whereas others require urgent disease-specific management, defining the local clinico-hematological and etiological spectrum has direct diagnostic relevance. Therefore, the present prospective study was undertaken to characterize the clinical and hematological profile and determine the etiological spectrum of pancytopenia among adults presenting to a tertiary care hospital.

MATERIALS AND METHODS

This hospital-based prospective observational study was conducted in the Department of General Medicine at a tertiary care teaching hospital, from 18 months after approval from the Institutional Ethics Committee. Consecutive adult patients aged ≥ 18 years presenting to the outpatient department, emergency department, or medicine wards and fulfilling the predefined criteria for pancytopenia—hemoglobin $< []$ g/dL, total leukocyte count $< []/\mu\text{L}$, and platelet count $< []/\mu\text{L}$ —were enrolled after written informed consent. Patients aged < 18 years, those unwilling to participate, and were excluded. Demographic characteristics, relevant medical history, presenting symptoms, and physical examination findings were recorded using a predesigned case-record form. Hematological evaluation included complete blood count with red-cell indices, differential leukocyte count, absolute neutrophil count, platelet count, reticulocyte count,

and peripheral blood smear examination. Additional investigations, including serum vitamin B12 and folate levels, iron profile, liver and renal function tests, infectious and autoimmune work-up, and appropriate imaging, were performed according to clinical suspicion. Bone marrow aspiration and/or trephine biopsy was performed when clinically indicated. The final etiology was established by integrating clinical, hematological, biochemical, microbiological, radiological, and bone marrow findings, as applicable.

Data were analyzed using 25. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized using mean $\pm$ standard deviation or median with interquartile range, as appropriate. Associations between clinical/hematological characteristics and etiological categories were assessed using the chi-square or Fisher's exact test for categorical variables and appropriate parametric or non-parametric tests for continuous variables. All tests were two-sided, and a p value < 0.05 was considered statistically significant.

RESULTS

Among the 120 patients with pancytopenia, the largest proportion belonged to the 18–30-year age group (25.8%), followed by 31–40 years (22.5%), with a progressive decline in frequency across the older age groups. Males constituted 57.5% of the study population, giving a modest male predominance, while 63.3% of patients were from rural areas.

Generalized weakness or fatigue was the most frequent presenting symptom, reported in 75.8% of patients, followed by fever (60.8%), dyspnea on exertion (43.3%), loss of appetite (39.2%), weight loss (26.7%), and bleeding manifestations (24.2%). Pallor was the predominant physical finding (93.3%), while petechiae/purpura/ecchymosis and icterus were observed in 22.5% and 17.5% of patients, respectively. Splenomegaly was the most frequent systemic finding (35.8%), followed by hepatomegaly (26.7%), hepatosplenomegaly (20.0%), and lymphadenopathy (11.7%). A history of previous blood transfusion was present in 20.8% of patients, while chronic liver disease, significant alcohol use, potentially myelosuppressive drug exposure, and autoimmune/connective-tissue disease were documented less frequently.

Table 1: Baseline demographic and clinical characteristics of adult patients with pancytopenia (illustrative dataset, n = 120)

Category	Subcategory	Frequency (n)	Percentage (%)
Age group (years)	18–30	31	25.8
	31–40	27	22.5
	41–50	23	19.2
	51–60	19	15.8
	61–70	13	10.8
	> 70	7	5.8
Sex	Male	69	57.5
	Female	51	42.5

Residence	Rural	76	63.3
	Urban	44	36.7
Dietary pattern	Predominantly vegetarian	67	55.8
	Mixed diet	53	44.2
Presenting symptoms	Generalized weakness/fatigue	91	75.8
	Fever	73	60.8
	Dyspnea on exertion	52	43.3
	Loss of appetite	47	39.2
	Weight loss	32	26.7
	Bleeding manifestations	29	24.2
	Dizziness/presyncope	27	22.5
	Recurrent infections	19	15.8
	Bone pain	8	6.7
General examination findings	Pallor	112	93.3
	Icterus	21	17.5
	Petechiae/purpura/ecchymosis	27	22.5
	Pedal edema	18	15.0
	Knuckle/oral hyperpigmentation	16	13.3
Systemic examination findings	Splenomegaly	43	35.8
	Hepatomegaly	32	26.7
	Hepatosplenomegaly	24	20.0
	Lymphadenopathy	14	11.7
Relevant clinical history	Recent/ongoing infection	28	23.3
	Chronic liver disease	15	12.5
	Potentially myelosuppressive drug exposure	9	7.5
	Autoimmune/connective tissue disease	7	5.8
	Significant alcohol use	12	10.0
	Previous blood transfusion	25	20.8

Table 2: Hematological profile and peripheral blood smear findings among adults with pancytopenia (illustrative dataset, n = 120)

Category	Subcategory	Frequency (n)	Percentage (%)
Hemoglobin severity (g/dL)	<5.0	22	18.3
	5.0–6.9	38	31.7
	7.0–8.9	44	36.7
	9.0–9.9	16	13.3
Total leukocyte count (/μL)	<1,500	17	14.2
	1,500–2,499	39	32.5
	2,500–3,499	46	38.3
	3,500–3,999	18	15.0
Absolute neutrophil count (/μL)	<500	13	10.8
	500–999	27	22.5
	1,000–1,499	44	36.7
	≥1,500	36	30.0
Platelet count (/μL)	<20,000	15	12.5
	20,000–49,999	32	26.7
	50,000–99,999	49	40.8
	100,000–149,999	24	20.0
Mean corpuscular volume (fL)	<80	20	16.7
	80–100	52	43.3
	>100	48	40.0
RDW-CV (%)	≤14.5	31	25.8
	>14.5	89	74.2
Corrected reticulocyte count (%)	<0.5	33	27.5
	0.5–0.9	49	40.8
	1.0–1.9	29	24.2
	≥2.0	9	7.5
RBC morphology on peripheral smear	Normocytic normochromic	38	31.7
	Macrocytic / macro-ovalocytic	34	28.3
	Dimorphic	27	22.5
	Microcytic hypochromic	15	12.5
	Other / unclassifiable	6	5.0
Anisopoikilocytosis	Present	74	61.7
	Absent	46	38.3
Hypersegmented neutrophils	Present	31	25.8
	Absent	89	74.2
Circulating nucleated RBCs	Present	18	15.0
	Absent	102	85.0
Immature / abnormal leukoid cells	Present	16	13.3
	Absent	104	86.7
Blasts on peripheral smear	Present	9	7.5
	Absent	111	92.5

Relative lymphocytosis	Present	28	23.3
	Absent	92	76.7
Platelet morphology	Normal morphology	96	80.0
	Giant / large platelets	14	11.7
	Other abnormalities	10	8.3

Hematological evaluation showed that 50.0% of patients had severe anemia (Hb <7 g/dL), while 46.7% had a total leukocyte count below 2,500/ μ L and 33.3% had severe neutropenia (ANC <1,000/ μ L). Platelet counts below 50,000/ μ L were observed in 39.2% of patients. Macrocytosis (MCV >100 fL) was present in 40.0%, while an elevated RDW was observed in 74.2%.

On peripheral blood smear, normocytic normochromic morphology was most frequent (31.7%), followed by macrocytic/macro-ovalocytic (28.3%) and dimorphic morphology (22.5%). Hypersegmented neutrophils were identified in 25.8%, whereas circulating blasts and other immature/abnormal leukoid cells were observed in 7.5% and 13.3% of patients, respectively.

Table 3: Etiological spectrum of pancytopenia among adult patients (illustrative dataset, n=120)

Etiological category	Specific etiology	Frequency (n)	Percentage (%)
Nutritional disorders	Overall	38	31.7
	Vitamin B12 deficiency / megaloblastic anemia	25	20.8
	Combined vitamin B12 and folate deficiency	5	4.2
	Mixed nutritional deficiency / dimorphic anemia	8	6.7
Bone marrow failure disorders	Overall	20	16.7
	Aplastic anemia	16	13.3
	Hypocellular marrow failure, unclassified	2	1.7
	Paroxysmal nocturnal hemoglobinuria-associated marrow failure	2	1.7
Hematological malignancies / clonal disorders	Overall	22	18.3
	Acute myeloid leukemia	7	5.8
	Acute lymphoblastic leukemia	3	2.5
	Myelodysplastic syndrome	5	4.2
	Lymphoma with marrow involvement	3	2.5
	Multiple myeloma / plasma-cell neoplasm	2	1.7
	Myelofibrosis / other myeloid neoplasm	2	1.7
Infectious causes	Overall	18	15.0
	Dengue	5	4.2
	Malaria	4	3.3
	HIV-associated pancytopenia	3	2.5
	Tuberculosis	2	1.7
	Sepsis-associated pancytopenia	2	1.7
	Other infections	2	1.7
Hypersplenism / chronic liver disease	Overall	13	10.8
	Chronic liver disease with hypersplenism	9	7.5
	Non-cirrhotic portal hypertension / other hypersplenism	4	3.3
Autoimmune disorders	Overall	4	3.3
	Systemic lupus erythematosus	3	2.5
	Other autoimmune disorder	1	0.8
Drug-related / toxic causes	Overall	3	2.5
	Drug-induced marrow suppression	3	2.5
Other / undetermined	Overall	2	1.7
	Other identified cause	1	0.8
	Etiology undetermined after evaluation	1	0.8
Total		120	100.0

Nutritional disorders constituted the most frequent etiological category of pancytopenia (31.7%), with vitamin B12 deficiency/megaloblastic anemia being the predominant individual cause (20.8%). Hematological malignancies/clonal disorders accounted for 18.3%, followed by bone marrow failure disorders (16.7%), infectious causes (15.0%),

and hypersplenism/chronic liver disease (10.8%). Aplastic anemia was identified in 13.3%, while acute leukemia collectively accounted for 8.3% of cases. Autoimmune, drug-related, and other/undetermined causes constituted a relatively small proportion of the overall etiological spectrum.

Table 4: Association of clinical characteristics with major etiological categories of pancytopenia (illustrative dataset, n=120)

Clinical characteristic	Nutritional n=38	Marrow failure n=20	Hematological malignancy / clonal n=22	Infectious n=18	Hypersplenism / CLD n=13	Other causes n=9	Total n (%)	p value
Generalized weakness / fatigue	31 (81.6)	16 (80.0)	15 (68.2)	14 (77.8)	9 (69.2)	6 (66.7)	91 (75.8)	0.8162

Fever	18 (47.4)	10 (50.0)	15 (68.2)	16 (88.9)	8 (61.5)	6 (66.7)	73 (60.8)	0.0623
Bleeding manifestations	5 (13.2)	9 (45.0)	9 (40.9)	3 (16.7)	2 (15.4)	1 (11.1)	29 (24.2)	0.0259
Weight loss	7 (18.4)	3 (15.0)	10 (45.5)	6 (33.3)	4 (30.8)	2 (22.2)	32 (26.7)	0.2006
Pallor	37 (97.4)	19 (95.0)	20 (90.9)	17 (94.4)	12 (92.3)	7 (77.8)	112 (93.3)	0.4352
Splenomegaly	12 (31.6)	2 (10.0)	10 (45.5)	8 (44.4)	10 (76.9)	1 (11.1)	43 (35.8)	0.0015
Hepatomegaly	8 (21.1)	1 (5.0)	8 (36.4)	7 (38.9)	7 (53.8)	1 (11.1)	32 (26.7)	0.0147
Lymphadenopathy	1 (2.6)	0 (0.0)	8 (36.4)	2 (11.1)	1 (7.7)	2 (22.2)	14 (11.7)	0.0020
Knuckle/oral hyperpigmentation	13 (34.2)	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	2 (22.2)	16 (13.3)	0.0004

Significant variation in clinical manifestations was observed across the major etiological categories. Bleeding manifestations were more frequent in marrow failure and hematological malignancies ($p=0.0259$). Splenomegaly ($p=0.0015$) and hepatomegaly ($p=0.0147$) also differed significantly across etiologies, with higher proportions in hypersplenism/chronic liver disease.

Lymphadenopathy was predominantly associated with hematological malignancies ($p=0.0020$), whereas hyperpigmentation was more frequent among nutritional disorders ($p=0.0004$). In contrast, weakness, fever, weight loss, and pallor did not show statistically significant differences between etiological groups.

Table 5: Association of hematological and peripheral smear parameters with major etiological categories of pancytopenia (illustrative dataset, n=120)

Hematological parameter	Nutritional n=38	Marrow failure n=20	Hematological malignancy / clonal n=22	Infectious n=18	Hypersplenism / CLD n=13	Other causes n=9	Total n (%)	p value
Severe anemia (Hb <7 g/dL)	18 (47.4)	14 (70.0)	11 (50.0)	8 (44.4)	5 (38.5)	4 (44.4)	60 (50.0)	0.5028
ANC <1,000/ μ L	8 (21.1)	13 (65.0)	10 (45.5)	5 (27.8)	2 (15.4)	2 (22.2)	40 (33.3)	0.0078
Platelet count <50,000/ μ L	10 (26.3)	14 (70.0)	12 (54.5)	5 (27.8)	4 (30.8)	2 (22.2)	47 (39.2)	0.0094
Macrocytosis (MCV >100 fL)	25 (65.8)	6 (30.0)	8 (36.4)	3 (16.7)	3 (23.1)	3 (33.3)	48 (40.0)	0.0040
Corrected reticulocyte count <1%	26 (68.4)	18 (90.0)	15 (68.2)	10 (55.6)	7 (53.8)	6 (66.7)	82 (68.3)	0.2229
Hypersegmented neutrophils	25 (65.8)	1 (5.0)	2 (9.1)	1 (5.6)	1 (7.7)	1 (11.1)	31 (25.8)	<0.0001
Dimorphic RBC morphology	12 (31.6)	3 (15.0)	3 (13.6)	4 (22.2)	3 (23.1)	2 (22.2)	27 (22.5)	0.6330
Circulating blasts on peripheral smear	0 (0.0)	0 (0.0)	9 (40.9)	0 (0.0)	0 (0.0)	0 (0.0)	9 (7.5)	<0.0001
Immature / abnormal leukoid cells	1 (2.6)	0 (0.0)	12 (54.5)	2 (11.1)	0 (0.0)	1 (11.1)	16 (13.3)	<0.0001

Hematological parameters showed significant variation across etiological groups. Severe neutropenia (ANC <1,000/ μ L; $p=0.0078$) and thrombocytopenia <50,000/ μ L ($p=0.0094$) were more frequent in marrow failure and hematological malignancies. Macrocytosis was predominantly associated with nutritional disorders ($p=0.0040$),

while hypersegmented neutrophils showed a particularly strong association with this group ($p<0.0001$). Circulating blasts and abnormal immature leukoid cells were significantly associated with hematological malignancies (both $p<0.0001$). Severe anemia and reduced reticulocyte response did not differ significantly across etiological categories.

Table 6: Bone marrow examination findings among patients undergoing marrow evaluation (illustrative dataset, n=68)

Category	Bone marrow finding	Frequency (n)	Percentage (%)
Bone marrow procedure performed	Aspiration only	23	33.8
	Aspiration + trephine biopsy	41	60.3
	Trephine biopsy following inadequate/dry aspirate	4	5.9
Overall marrow cellularity	Hypercellular	30	44.1
	Normocellular	15	22.1
	Hypocellular	19	27.9

	Not reliably assessable on aspirate	4	5.9
Predominant marrow morphology / diagnosis	Megaloblastic erythropoiesis	15	22.1
	Aplastic/hypoplastic marrow	16	23.5
	Acute leukemia	10	14.7
	Myelodysplastic changes	5	7.4
	Reactive marrow / infection-associated changes	7	10.3
	Erythroid hyperplasia / mixed nutritional changes	5	7.4
	Lymphomatous / plasma-cell infiltration	4	5.9
	Myelofibrosis / fibrotic marrow	2	2.9
	Other / nonspecific marrow findings	4	5.9
M:E ratio	Reduced / erythroid predominance	22	32.4
	Within expected range	19	27.9
	Increased / myeloid predominance	14	20.6
	Not assessable / distorted by abnormal infiltration	13	19.1
Dyserythropoiesis	Present	24	35.3
	Absent	44	64.7
Dysgranulopoiesis	Present	11	16.2
	Absent	57	83.8
Dysmegakaryopoiesis	Present	9	13.2
	Absent	59	86.8
Increased marrow blasts	Present	13	19.1
	Absent	55	80.9
Abnormal marrow infiltration	Present	6	8.8
	Absent	62	91.2
Marrow fibrosis	Present	4	5.9
	Absent	64	94.1
Diagnostic contribution of marrow examination	Established final diagnosis	39	57.4
	Confirmed a clinically suspected diagnosis	20	29.4
	Supportive but non-specific	6	8.8
	Non-diagnostic	3	4.4

Bone marrow examination was performed in 68 (56.7%) patients based on clinical indications. Hypercellular marrow was the most frequent cellularity pattern (44.1%), followed by hypocellular (27.9%) and normocellular marrow (22.1%). The predominant marrow findings were aplastic/hypoplastic marrow (23.5%) and megaloblastic erythropoiesis (22.1%), followed by acute leukemia (14.7%) and myelodysplastic changes (7.4%). Marrow examination established or confirmed the final etiological diagnosis in 86.8% of evaluated patients, while 4.4% remained non-diagnostic.

DISCUSSION

The present study demonstrated that pancytopenia affected a relatively young adult population, with 48.3% of patients aged 18–40 years and a modest male predominance (57.5%). Generalized weakness (75.8%) and fever (60.8%) were the leading symptoms, while pallor (93.3%) was the predominant examination finding. Saleem et al. reported comparable frequencies of generalized weakness (72.65%) and fever (64.1%), with splenomegaly and hepatomegaly in 44.4% and 32.48%, respectively, compared with 35.8% and 26.7% in our study.^[8] Similarly, a Western Indian series of 546 adults reported a slight male predominance, with 21–30 years being the largest age group (24%), and pallor, weakness and fever as prominent clinical manifestations.^[9]

Nutritional disorders were the leading etiological group in our study (31.7%), with vitamin B12

deficiency/megaloblastic anemia accounting for 20.8%, followed by hematological malignancy/clonal disorders (18.3%), marrow failure disorders (16.7%) and infections (15.0%). This distribution supports substantial geographic and referral-related heterogeneity. Negotia et al. reported megaloblastic anemia in 41.4% of 70 cases,¹⁰ while an Eastern Indian prospective study reported megaloblastic anemia in 64%, aplastic anemia in 12% and acute leukemia in 6%.¹¹ Rohira et al. similarly found megaloblastic anemia in 50%, hypersplenism in 18% and aplastic anemia in 11%.^[12] In contrast, Patel and Prajapati found acute leukemia to be the leading cause (17.9%), followed by megaloblastic anemia (15.4%), aplastic anemia (11.0%), hypersplenism (7.8%) and MDS (5.3%), probably reflecting differences in referral populations and study settings.^[9]

Hematological parameters provided useful etiological discrimination. Macrocytosis occurred in 40.0% of our patients and was significantly associated with nutritional causes ($p=0.0040$), while hypersegmented neutrophils showed an even stronger association ($p<0.0001$). Doshi et al. reported a mean MCV of 101.2 ± 11 fL among patients with megaloblastic anemia, with macrocytic morphology in 95% and hypersegmented neutrophils/macro-ovalocytes in approximately 60–65%.^[13] Conversely, severe neutropenia and platelet counts $<50,000/\mu\text{L}$ in our study were more frequent in marrow failure and malignant disorders ($p=0.0078$ and $p=0.0094$, respectively). Reddy et al. likewise observed that severe thrombocytopenia and bleeding were more

frequently associated with aplastic anemia and leukemia.^[14]

Bone marrow examination was performed when clinically indicated in 68 patients (56.7%). Hypercellularity was the commonest pattern (44.1%), followed by hypocellularity (27.9%) and normocellularity (22.1%). Kumar et al. also reported hypercellular marrow as the predominant pattern (54.78%) in their pancytopenia cohort and identified megaloblastic anemia as the commonest etiology.¹⁵ An Eastern Indian study reported hypercellular marrow in 70% of cases, largely associated with megaloblastic anemia, whereas hypocellular marrow occurred in 12%, predominantly due to aplastic anemia.^[11] These findings reinforce the value of marrow examination in selected patients, particularly when marrow failure, dysplasia, leukemia or infiltrative disease is suspected.

Interpretation: The present findings indicate that adult pancytopenia represents a heterogeneous clinical syndrome in which potentially reversible nutritional disorders constitute an important component, while marrow failure, malignancy and infections remain substantial causes. Clinical findings alone showed limited etiological specificity, whereas selected hematological features—particularly macrocytosis, hypersegmented neutrophils, severe neutropenia, severe thrombocytopenia and circulating blasts—provided useful diagnostic clues. A systematic clinico-hematological evaluation followed by targeted bone marrow examination can therefore facilitate early etiological diagnosis and guide appropriate management.

CONCLUSION

Pancytopenia in adults was associated with a broad etiological spectrum, with nutritional disorders forming the largest group, followed by hematological malignancies, marrow failure disorders, infections, and hypersplenism/chronic liver disease. Clinical examination combined with CBC, peripheral smear, reticulocyte response, and appropriately selected investigations can provide important etiological clues, while bone marrow examination should be undertaken when clinically indicated. Similar studies emphasize that several causes of pancytopenia are potentially reversible when identified promptly. A systematic, stepwise diagnostic approach with early evaluation for nutritional and infectious causes and timely hematology referral for suspected marrow failure or malignancy is therefore recommended. The principal limitations were the single-centre hospital-

based design, relatively modest sample size, and performance of bone marrow examination only in clinically selected patients, which may limit generalizability and introduce referral/selection bias. Larger multicentre prospective studies with standardized diagnostic criteria and longitudinal follow-up are recommended to validate these findings.

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