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Frequency of Aplastic Anemia on Bone Marrow Examination in Pediatric Patients with Pancytopenia on Peripheral Smear Presented to MTI-LRH Peshawar

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ABSTRACT

Background: Aplastic anemia is a serious condition affecting the bone marrow and involves the impaired function of hematopoietic stem cells, which leads to reduced production of red blood cells, white blood cells, and platelets in the blood. Pancytopenia is the clinical expression of bone marrow failure that is frequently observed in children with symptoms of anemia, infection, and bleeding phenomena. The accurate measurement of aplastic anemia in pancytopenia can help in understanding the magnitude of the problem and can be useful in improving diagnostic awareness in resource-constraint regions. **Objective:** To determine the frequency of aplastic anemia on bone marrow examination in patients with pancytopenia. **Study Design:** Cross-sectional descriptive study. **Duration and Place of Study:** The study was conducted from January 2024 to June 2024 at the Department of Pediatrics, Lady Reading Hospital, Peshawar. **Methodology:** A total of 148 children aged 1–15 years with pancytopenia confirmed on peripheral smear were enrolled through consecutive sampling. Bone marrow aspiration and biopsy were performed using standard sterile techniques. Samples were assessed microscopically for cellularity and hematopoietic elements. Aplastic anemia was diagnosed when marrow showed hypocellularity with reduction of at least two hematopoietic cell lines. **Results:** Out of 148 patients, 79 were males and 69 were females with mean age 7.93 ± 4.47 years. Aplastic anemia was found in 30 patients (20.30%), while 118 (79.70%) had other causes. No significant association was observed with age, gender, or body weight. **Conclusion:** Aplastic anemia is a notable cause of pancytopenia among children in Peshawar.

INTRODUCTION

Aplastic anemia is a disorder of bone marrow in which the production of blood cells is severely reduced because the stem cells fail to grow and multiply.[1] In this condition, the bone marrow becomes hypocellular with marked decrease in erythroid, myeloid, and megakaryocytic lineages.[2] The cause may be idiopathic or secondary to drugs, chemicals, viral infections, or radiation exposure.[3] Patients present with signs of anemia like fatigue, pallor, and shortness of breath, and also with infections due to low white cells and bleeding tendency due to low platelets.[4] Bone marrow biopsy shows fatty replacement with very few hematopoietic cells, and no evidence of abnormal infiltration or fibrosis.[5] The condition is different from marrow suppression seen in malignancy because here the marrow is empty rather than replaced.[6]

Pancytopenia is the reduction of all three main blood cell lines in the peripheral circulation, which are red cells, white cells, and platelets.[7] It is not a disease itself but a manifestation of many underlying disorders including aplastic anemia, megaloblastic anemia, leukemia, and hypersplenism.[8] The patients exhibit signs of weakness, pallor, frequent infections, and easy bruising or bleeding.[9] On peripheral smear examination, red blood cells are normocytic or macrocytic, WBCs are low, and platelet counts are severely low.[7] The bone marrow examination may reveal hypoplasmia or hyperplasia depending on the etiology.[7] While in aplastic anemia, the marrow is hypoplastic, in other causes such as leukemia or megaloblastic anemia, it is hyperplastic.[3]

The peripheral smear and bone marrow examination in aplastic anemia are based on the absence or marked reduction of blood-forming cells.[10] In peripheral smear examination, there is a remarkable reduction in the number of all blood elements, but there are no abnormal or blast cells in the smear.[10] The red blood cells are normocytic and normochromic, while there are very low counts of white blood cells and platelets with no immature elements in the smear.[11] The bone marrow biopsy would be dry tap because of the hypocellularity in aplastic anemia, while the histology examination confirms the diagnosis due to the remarkable increase in fatty

infiltration with sparse hematopoietic areas in the study group.[12] The cellularity would be less than 25% with no fibrosis or malignant infiltration.[12]

In a study by Samreen Z, et al. has shown that frequency of aplastic anemia was 44% on bone marrow examination in patients with pancytopenia.[13]

This study need to be done in Peshawar because many patients come with pancytopenia but exact cause not always clear, and many cases remain undiagnosed due to lack of proper bone marrow examination. In this region, people often delay hospital visit and present late with severe anemia or bleeding which make diagnosis more difficult. By doing this study, it will help to know how common aplastic anemia is among pancytopenia cases and improve understanding of local pattern of bone marrow failure. It will also support doctors to make early diagnosis and better management plan for patients in Peshawar hospitals.

METHODOLOGY

This study was done in the Department of Pediatrics, Lady Reading Hospital Peshawar, from January 2024 to June 2024. It was a cross-sectional study. The total 148 patients were included, and this number had been decided through WHO sample size calculator, taking 95% confidence level, 8% error margin, and the expected 44% occurrence of aplastic anemia.[13] The participants were taken by non-probability consecutive method.

The ethical clearance had been granted before the study started from the institutional review board of LRH Peshawar (Ref: No. 1020/LRH/ MTI). The research included children from 1 to 15 years, both boys and girls, who had pancytopenia, which was confirmed when hemoglobin was below 12 g/dL in girls and 13 g/dL in boys, platelets less than 150,000 per µL, and leukocytes less than 4000 per µL, or neutrophils below 1800 per µL. Children receiving cancer therapy, cytotoxic or anti-metabolic drugs, or radiation were not considered because these factors could change the bone marrow picture.

Before data were collected, parents or guardians of the patients were informed about the aim and safety of the study, and consent had been taken voluntarily. Basic information such as age, gender, and body weight was gathered. Then, the procedure of bone marrow aspiration and biopsy has been conducted utilizing the Jamshidi needle in accordance with correct sterile procedure. The slides were stained in accordance with the Gordon and Sweet's reticulin stain technique, with the aim of scrutinizing them in the microscope to identify marrow cellularity, proportions of myeloid, erythrocytic, and megakaryocytes, as well as any abnormal accumulation or fibrosis. The diagnosis for aplastic anemia was confirmed when the bone marrow showed reduced cell content together with at least two types of blood cell shortage such as reticulocyte count below 1 percent or 40,000 per µL, neutrophils below 500 per µL, or platelets under 20,000 per µL. All results were written in a pre-designed sheet for later review.

For analysis, the data had been processed using IBM SPSS version 26. The numerical factors like age and weight were shown as mean ± standard deviation, while gender and presence of aplastic anemia were shown as frequency and percent. The occurrence of aplastic anemia was further compared across age groups, gender, and weight, and a chi-square test had been applied with significance taken at $p \leq 0.05$.

RESULTS

The present study included a total of 148 patients with pancytopenia on peripheral smear, having mean age of 7.93 ± 4.47 years and mean weight of 25.21 ± 11.08 kg. Out of these patients, 79 (53.4%) was males and 69 (46.6%) was females (as shown in Table-I).

Table I

Patient Demographics

Demographics	Mean ± SD
Age (years)	7.93 ± 4.47
Weight (kg)	25.21 ± 11.08
Gender	
Male n (%)	79 (53.4%)
Female n (%)	69 (46.6%)

On bone marrow examination, aplastic anemia were diagnosed in 30 (20.30%) patients, while 118 (79.70%) patients did not had aplastic anemia (as shown in Table-II).

Table II

Frequency of Aplastic Anemia on Bone Marrow Examination in Patients with Pancytopenia on Peripheral Smear

Aplastic Anemia	Frequency	% age
Yes	30	20.30%
No	118	79.70%
Total	148	100%

When demographic factors was analyzed in relation to aplastic anemia, it were found that among patients aged ≤10 years, 20 (20.4%) had aplastic anemia and 78 (79.6%) did not had it, whereas among patients aged >10 years, 10 (20.0%) had aplastic anemia and 40 (80.0%) did not had it, with p-value of 0.953 showing no significant association. Regarding gender distribution, aplastic anemia were present in 18 (22.8%) males and 61 (77.2%) males did not had it, while among females, 12 (17.4%) had aplastic anemia and 57 (82.6%) did not had it, with p-value of 0.416 indicating no significant association. For weight stratification, among patients weighing ≤25 kg, 17 (20.7%) had aplastic anemia and 65 (79.3%) did not had it, while among patients weighing >25 kg, 13 (19.7%) had aplastic anemia and 53 (80.3%) did not had it, with p-value of 0.876 showing no significant association (as shown in Table-III).

Table III

Association of Aplastic Anemia with Demographic Factors

Demographic Factors		Aplastic Anemia		p-value
		Yes n(%)	No n(%)	
Age (years)	≤10	20 (20.4%)	78 (79.6%)	0.953*
	>10	10 (20.0%)	40 (80.0%)	
Gender	Male	18 (22.8%)	61 (77.2%)	0.416*
	Female	12 (17.4%)	57 (82.6%)	
Weight (Kg)	≤25	17 (20.7%)	65 (79.3%)	0.876*
	>25	13 (19.7%)	53 (80.3%)	

*Chi-Square Test

DISCUSSION

The present study had been done to find how often aplastic anemia was seen on bone marrow test among children who showed pancytopenia on peripheral smear. The finding that one-fifth of children had aplastic anemia showed that bone marrow failure was a notable cause of pancytopenia in our setup. This may be due to poor nutrition, repeated infections, or drug exposure that could damage the bone marrow cells in children. When comparing age groups, almost equal frequency was seen in children below and above 10 years. This means that the disease can appear at any childhood stage and not limited to a specific age because marrow suppression may occur after viral illness or unknown trigger in both small and older children. Gender-wise, aplastic anemia were seen little more in males than females, but the difference was not big. This might be because boys are often more exposed to outdoor infections and toxins, but genetic and environmental factors affect both genders similarly. The result about body weight showed that aplastic anemia had almost same rate among children weighing below and above 25 kg. This indicated that weight alone had no clear link with marrow failure because the condition depends more on hematopoietic suppression than on body mass.

The frequency of aplastic anemia in present study were found to be 20.30%, which was lower than several regional studies but comparable to some others. Kaleem Z, et al.[14] reported frequency of 33.2% in pediatric patients from Lahore, while Younas M, et al.[15] found 32.4% in children at Rawalpindi, both showing higher rates than our findings. Similarly, Mehwish F, et al.[16] documented highest frequency of 43.8% among children in Multan and Bahawalpur region. In contrast, Khan TA, et al.[17] reported 37.5% frequency in mixed age population at Peshawar, and Memon S, et al.[18] found 23.9% in pediatric cases at Jamshoro, which was more closer to our results. The most striking difference was observed in study by Zeb F, et al.[19] who reported remarkably high frequency of 76.3% in adult patients from Peshawar, suggesting that aplastic anemia may be more prevalent in older age groups. These discrepancies in rates can be explained on account of various reasons such as difference in age group of study populations, geographic variations, sample sizes, and diagnostic criteria employed by different studies. The current study was conducted on relatively younger patients with average age of 7.93 ± 4.47 years, whereas the studies with relatively higher rates such as Zeb F, et al.[19] were conducted on adults with average age of 55 ± 12.85 years, suggesting susceptibility at varying ages. The relatively lower rates in our study might also suggest early detection and management of nutrition deficiencies in our region, which would help in averting the condition from advancing to marrow failure. In addition to that, there might be variations in exposure to toxins/ dietary habits in different parts of Pakistan, adding to geographic variations in aplastic anemia cases.

Coming to demographic associations, there was no significant association between aplastic anemia and age ($p = 0.953$), gender ($p = 0.416$), and weight ($p = 0.876$) in our study, which was in accordance with the study done by Kaleem Z, et al.[14] and Younas M, et al.[15] who demonstrated that there were no significant differences in respect of age group, gender, and socioeconomic status. Few studies demonstrated variations with respect to demographic associations for gender distribution. Abbasi S, et al.[20] demonstrated preponderance in males with 56% in males and 44% in females in total pancytopenia patients, whereas in our study, it was 53.4% in males and 46.6% in females, demonstrating equality in gender distributions. Khan TA, et al.[17] demonstrated the ratio of males to females being 1.5:1. In contrast, Khan Y, et al.[21] found female predominance in adult population with 62% females and 38% males. Arshad M, et al.[22] suggested that younger age and male predominance in their aplastic anemia cases might indicates genetic predisposition in South Asian populations, though our study did not confirms this gender-based difference. The mean age in our study was 7.93 ± 4.47 years with mean weight of 25.21 ± 11.08 kg, which was considerably lower than adult studies like Khan Y, et al.[21] who reported mean age of 42 ± 15.84 years and Zeb F, et al.[19] with mean age of 55 ± 12.85 years. This age difference was expected given our pediatric focus and was comparable to Kaleem Z, et al.[14] who studied children with mean age of 6.7 ± 3.69 years.

When comparing causes of pancytopenia, different studies showed varying etiological patterns. While aplastic anemia was leading cause in studies by Khan TA, et al.[17] with 37.5%, Mehwish F, et al.[16] with 43.8%, and Memon S, et al.[18] with 23.9%, other studies identified megaloblastic anemia as predominant etiology. Abbasi S, et al.[20] observed the incidence of megaloblastic anemia in 42% cases, aplastic anemia in 22%, whereas Khattak MB, et al.[23] studied patients with primary megaloblastic anemia, who presented with pancytopenia in 70% cases. Khan Y, et al.[21] observed the incidence of megaloblastic anemia in 40% cases, aplastic anemia in 23% in adults, which clearly showed that in communities with good dietary habits, aplastic anemia might be less likely in comparison to others. These differences suggests that etiological spectrum of pancytopenia varies with age groups, geographical locations, and nutritional status of populations. Younger patients in our study and similar pediatric cohorts may have different causative factors compared to adult populations, with marrow failure being more prominent in children whereas nutritional deficiencies predominates in adults. The absence of significant associations with demographic factors in our study and in studies by Kaleem Z, et al.[14] and Younas M, et al.[15] indicates that aplastic anemia affects patients equally regardless of age, gender, or socioeconomic status within pediatric populations, though Younas M, et al.[15] noted that 50.4% patients were from middle-class families and Kaleem Z, et al.[14] reported 48.6% from middle class, suggesting accessibility to healthcare facilities rather than disease predisposition.

This study had some limits that must be kept in mind. It was done in a single center, so the results may not fully show the pattern in other hospitals or regions. The sample was small in size, which may not encompass all the reasons that can cause pancytopenia in patients. The study duration was short, and patients were not followed up, so it was not possible to evaluate the final result in patients. Certain lab and molecular analyses were not performed

because of resource constraints, which can impact understanding to a deeper level on why the disease was caused to patients. Nonetheless, the data provides insights on the general trend viewed in our current setting.

CONCLUSION

The conclusion has been drawn from our study that aplastic anemia can be one of the main causes of pancytopenia in children because it has been revealed that the failure of the bone marrow has importance in aplastic anemia. The occurrence was not related to the ages, gender, or weights of the children because it can occur in any group of children.

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REFERENCES

1. Solimando, A. G., Palumbo, C., Pragnell, M. V., Bittrich, M., Argentiero, A., & Krebs, M. (2022). Aplastic anemia as a roadmap for bone marrow failure: An overview and a clinical workflow. *International Journal of Molecular Sciences*, *23*(19), 11765. https://doi.org/10.3390/ijms231911765
2. Sweeney, R., Esmail, F., Mirza, K. M., & Nand, S. (2021). Hypercellular bone marrow in aplastic anemia: A case report of two patients. *Clinical Case Reports*, *9*(11). https://doi.org/10.1002/ccr3.4845
3. Youssef, M. A., Hmed, E. S., Kamal, D. T., Elsayh,, K., Abdelfatta, M. A., Mahran, H. H., & Embaby, M. (2024). Clinical signs and treatment of new-onset bone marrow failure associated SARS-Cov-2 infection in children : A single institution prospective cohort study . *Mediterranean Journal of Hematology and Infectious Diseases*, *16*(1), e2024034. https://doi.org/10.4084/mjhid.2024.034
4. Proskuriakova, E., Jasaraj, R. B., San Hernandez, A. M., Sakhuja, A., Khoury, M., & Khosla, P. (2023). A case of severe aplastic anemia in a 35-Year-Old male with a good response to immunosuppressive therapy. *Cureus*. https://doi.org/10.7759/cureus.40210
5. Kasinathan, G., Lee, B. S., & Sathar, J. (2021). Very severe aplastic anemia in an 80-year-old man. *Clinical Case Reports*, *9*(3), 1330-1333. https://doi.org/10.1002/ccr3.3757
6. Sharma, V., Rawat, S., Gupta, S., Tamta, S., Sharma, R., Seth, T., & Mohanty, S. (2021). Human acquired aplastic anemia patients' bone-marrow-Derived Mesenchymal stem cells are not influenced by hematopoietic compartment and maintain Stemness and immune properties. *Anemia*, *2021*, 1-9. https://doi.org/10.1155/2021/6678067
7. Chew, S., & Kamangar, M. (2024). Approach to pancytopenia: From blood tests to the bedside. *Clinical Medicine*, *24*(5), 100235. https://doi.org/10.1016/j.clinme.2024.100235
8. Patel, G. R., & Prajapati, G. R. (2022). Spectrum of Pancytopenia in adults attending a clinical hematology department: A four-year experience from a tertiary care center of western India. *Cureus*. https://doi.org/10.7759/cureus.24933
9. Nodeh, M. M., Rezaieyazdi, Z., Karimoddini, M., Jafarian, A. H., & Ghamari, M. (2025). Systemic lupus Erythematosus presenting with autoimmune Myelofibrosis in a young woman: A case report. *Clinical Case Reports*, *13*(4). https://doi.org/10.1002/ccr3.70362
10. Kakiuchi, T., Eguchi, K., Koga, D., Eguchi, H., Nishi, M., Sonoda, M., Ishimura, M., & Matsuo, M. (2022). Changes in bone marrow and peripheral blood lymphocyte subset findings with onset of hepatitis-associated aplastic anemia. *Medicine*, *101*(8), e28953. https://doi.org/10.1097/md.0000000000028953
11. Kebede, S. S., Yalew, A., Yesuf, T., Melku, M., Bambo, G. M., & Woldu, B. (2022). The magnitude and associated factors of immune hemolytic anemia among human immuno deficiency virus infected adults attending University of Gondar comprehensive specialized hospital north west Ethiopia 2021 GC, cross sectional study design. *PLOS ONE*, *17*(10), e0274464. https://doi.org/10.1371/journal.pone.0274464
12. Bonadies, N., Rovó, A., Porret, N., & Bacher, U. (2021). When should we think of Myelodysplasia or bone marrow failure in a Thrombocytopenic patient? A practical approach to diagnosis. *Journal of Clinical Medicine*, *10*(5), 1026. https://doi.org/10.3390/jcm10051026
13. Samreen, Z., Durrani, A. B., & Taj, M. K. (2019). Frequency of common etiologies of pancytopenia seen on bone marrow aspiration. *Journal of Saidu Medical College Swat*, *9*(2), 178-181. https://doi.org/10.52206/jsmc.2019.9.2.%25p
14. Kaleem, Z., Rehman, A., Rafique, M. A., & Altaf, A. (2022). Aplastic anemia in patients with new-onset Pancytopenia. *Pakistan Journal of Medical and Health Sciences*, *16*(4), 977-978. https://doi.org/10.53350/pjmhs22164977
15. Younas, M., Younas, M., Younas, A., & Aziz, M. (2024). Frequency of aplastic anemia in children with new onset pancytopenia on peripheral smear. *Journal of Population Therapeutics and Clinical Pharmacology*. https://doi.org/10.53555/jptcp.v31i4.5369
16. Mehwish, F., Shafique, S., & Fatima, B. (2022). Frequency of causes of Pancytopenia based on bone marrow smear results in patients 1 year to 12 years age. *Pakistan Journal of Medical and Health Sciences*, *16*(6), 244-245. https://doi.org/10.53350/pjmhs22166244
17. Khan, T. A., Khan, I. A., & Mahmood, K. (2013). Clinicohaematological spectrum of pancytopenia in a tertiary care hospital. *Journal of Postgraduate Medical Institute*, *27*(2). https://jpmi.org.pk/index.php/jpmi/article/view/1500
18. Memon, S., Shaikh, S., & Nizamani, M. A. (2008). Etiological spectrum of pancytopenia based on bone marrow examination in children. *J Coll Physicians Surg Pak*, *18*(3), 163-7. https://www.jcpsp.pk/archive/2008/Mar2008/08.pdf
19. Zeb, F., Pervez, S., Khan, A., Bilal, M., Khan, B., & Khan, A. (2022). Frequency of aplastic anemia among adults patient with Pancytopenia: A cross-sectional study design. *Pakistan Journal of Medical and Health Sciences*, *16*(11), 700-702. https://doi.org/10.53350/pjmhs20221611700
20. Abbasi, S. (2019). Clinico-pathological spectrum of Pancytopenia: A single centre study. *Liaquat Medical Research Journal*, *1*(1). https://doi.org/10.38106/lmrj.2019.1.1-03
21. Khan, Y., Athar, S., Khan, I., Taqveem, A., & Awan, B. (2018). Frequency of aplastic anemia and megaloplastic anemia as causes of pancytopenia in adults. *KJMS*, *11*(1), 72.

https://kjms.com.pk/old/sites/default/files/KJMS-16_1.pdf
22. Arshad, M., Ahmed, F., Ellahi, A., Saadia, A., Usman, J., & Ahmed, S. (2023). Hematological manifestations of aplastic anemia in patients with hypocellular marrow presenting in a tertiary care hospital in a developing country. *The Professional Medical Journal*, *30*(12), 1546-1550. https://doi.org/10.29309/tpmj/2023.30.12.7677
23. Khattak, M. B., Ismail, M., Marwat, Z. I., & Khan, F. (2012). Frequency and characterisation of pancytopenia in megaloblastic anaemia. *Journal of Ayub Medical College Abbottabad*, *24*(3-4), 53-55. https://jamc.ayubmed.edu.pk/index.php/jamc/article/view/1927