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Original Article

A Novel Approach in Interpretation of Blood Indices MCH and MCHC

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ABSTRACT

Introduction: Anemia is one of the most pressing public health issue in India. It is not a disease but only a manifestation of underlying disease. Complete blood count is the blood test used to diagnose the prevalence of anemia. Mean corpuscular hemoglobin (MCH) and Mean corpuscular hemoglobin concentration (MCHC) are derived parameters from Hemoglobin, RBC and Hematocrit, which reflects changes in erythrogram. Z Score is standardized Score, measures how many standard deviations a data point is from the mean in a distribution. Here we applied Z Score on MCH and MCHC and analyse the difference between Zmch and Zmchc in different types of Anemia.
Aim and Objective: Utility of Zmch, Zmchc and Z Score analysis in classification of Anemia.
Mathods and Materials: A total of 500 hemograms are studied. Basic statistically formulae using mean and standard deviation are applied to calculate Z Scores. Basically a difference between Zmch and Zmchc are compared in patients having different types of anemia.
Result: Z score is statistically significant in diagnosing Iron deficiency anemia, Megaloblasticanemia, Hemolyticanemia, Anemia of chronic disease and B thalasemia trait.
Conclusion: Hemogram is one of the first investigation ordered in all patients. Detailed analysis of blood indices – Zmch and Zmchc and their difference – Z Score help us to classify anemia and thereby we can directs further actions in patient management and treatment.

Key Words: *Z score, Zmch, Zmchc, Anemia*

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INTRODUCTION

Anemia is a decrease in the oxygen carrying capacity of blood. It can arise if the hemoglobin (Hb) concentration of red blood cells (RBCs) or packed cell volume of RBCs (PCV) is below the lower limit of reference interval for individual age, gender, geographical location and physiological status [1]. Hematologicalanalyzer gives Complete Blood Count, which measures RBCs count and its indices [2]. It can help in diagnosing anemia. Low RBC count is a key indicator of anemia. RBC Indices – measurement of the properties and numbers of red blood cells are commonly used for the diagnosis of various types of anemia. The development of indices with good diagnostic accuracy based on parameters derived from the blood cell counters would be useful in the clinical routine [3]. Any kind of mismatch between level of hemoglobin, red cell count and red cell indices, gives a clue to think about various types of anemia. Without prompt availability of clinical details, we can easily direct clinicians to guide about treatment and management of patient [4]. To deal with the above mentioned scenarios, "Z Score" to be applied on MCH and MCHC which can help in identify and classify anemia.

METHODS AND MATERIAL

Z score:

It is a measure of how dispersed the data is in relation to the mean. Data points above the mean have positive Z Score, while those below the mean have negative Z Scores. The standard definition of a reference range for a particular measurement is defined as the interval between which 95 % of values of a reference population fall into, in such away that 2.5 % of the time a value will be less than the lower limit of this interval, and 2.5 % of the time it will be larger than the upper limit of this interval.

Mean Corpuscular Hemoglobin (MCH) normal range - 23.8 to 33.4 pg
Mean Corpuscular Hemoglobin Concentration (MCHC) normal range-32.5 to 36.3 g/dL

u = Mean, UL = Upper limit, LL = Lower limit
δ = SD=Standard Deviation
x= Observed value
Note: Here we counted Mean MCH, Mean MCHC, Zmch and Zmchc from above normal value of MCH and MCHC.

Mean (u) = (UL + LL) / 2
SD (δ) = (u - LL)/2
Z Score = (x – u)/δ

Mean MCH = 28.6
Zmch = 2.4
Mean MCHC = 34.4
Zmchc = 0.95

RESULT

Total 500 cases are studied. Here some Examples are –

Sr. No.	RBC count	HB	HCT	MCV	MCH	MCHC	RDW	Zmch	Zmchc	Z Sco-re	Result
1	3.09	7.1	23.5	76	23.1	30.4	17.3	-2.292	-4.9	2.608	**IDA**
2	4.7	8.6	29.5	62.7	18.2	29	32.5	-4.333	-6.3	1.967	**IDA**
3	4.93	8.9	28.9	59.7	18.4	30.8	17.4	-4.250	-4.5	0.250	**BTT**
4	5.09	9.1	29.7	58.5	17.9	30.7	18.7	-4.458	-4.6	0.142	**BTT**
5	2.15	7.7	23.3	109	35.9	33	16.2	3.042	-2.3	0.742	**MA**
6	2.67	8.3	26.6	99.5	31.2	31.3	19.4	1.083	-4	2.917	**MA**
7	2.16	6.5	20.5	95	29.9	31.5	14.8	11.3	-3.8	3.258	**HA**
8	2.72	7.5	23.7	86.9	27.4	31.6	19.5	-0.500	-3.7	3.200	**HA**
9	3.17	8.4	27.4	86.4	26.4	30.6	19	-0.917	-4.7	3.783	**ACD**
10	2.94	8.3	26.4	90	28.2	31.3	16.4	0.167	-4	3.833	**ACD**

HB-Hemoglobin, HCT – Hematocrit, MCV- Mean Corpuscular Volume, MCH-Mean corpuscular hemoglobin, MCHC-Mean corpuscular hemoglobin concentration, RDW - Red cell distribution width
IDA- Iron deficiency Anemia, BTT- Beta Thalassemia Trait, MA-Megaloblastic Anemia
ACD- Anemia of Chronic Disease, HA- Hemolytic Anemia

We have divided 500 cases according their Z score value >10,5-10,4-5,3-4,1-3 and <1 ; where Zmchc is more then Zmch, into five sub type of anemia – IDA , MA , HA , ACD and BTT.

		IDA	MA	HA	ACD	BTT	TOTAL
Zmchc>Zmch	Z Score >10	1	5	0	0	0	6
	Z Score 5-10	7	6	13	19	0	45
	Z Score 4-5	22	5	15	26	0	68
	Z Score 3-4	50	5	27	48	0	130
	Z Score 1-3	102	32	34	54	6	228
	Z Score <1	0	9	1	2	11	23
		182	**62**	**90**	**149**	**17**	**500**
Opposite Direction		1	48	20	23	0	53
Zmch>Zmchc		0	8	0	0	0	8

DISCUSSION

- The 500 case studied comprising of 182 cases of IDA, 149 cases of ACD, 90 cases of HA, 62 cases of MA and 17 cases of BTT.

- 149 patients with **Anemia of chronic disease**, (Mean=3.49, SD=1.62) shows significance in independent t test. There is **significance in t (ACD)** = 2.0996, p-value is **0.0362**. The result is significant at p< 0.05.
- 17 patients with **Beta thalassemia trait**, (Mean=1.04, SD=0.78) shows significance in independent t test. There is **significance in t(BTT)** = -5.1951 , p-value is <**0.0001**. the result is significant at p< 0.05.
- 90 patients with **Hemolytic Anemia**, (Mean=3.59,SD=2.27) shows significance in independent t test. There is **significance in t(HA)** = 2.0464 , p-value is **0.0394**. the result is significant at p< 0.05.
- 182 patients with **iron deficiency Anemia**(Mean=3.03,SD=1.67) and 62 patients with **Megaloblastic Anemia**, (Mean=3.3,SD=12.67) shows no significance in independent t test. There is **no significance in IDA t(IDA)** = -1.9359 , p-value is **0.5344**.**nosignificance in t(MA)** = 0.3004 , p-value is **0.7639**. the result is not significant at p < 0.05. but large study with more data can be give more accurate diagnosis.

➢ **Iron Deficiency Anemia(IDA)(Z Score <= 2)and Beta thalasemia trait(BTT) (Z Score <1):**

Microcytic hypochromic blood picture has two main differentials. In IDA where heme synthesis and globin syntheis in BTT are prevented, Hb can not reaches to its critical concentration and in an attempt to achieve that critical value the RBC keeps dividing. Hence there are numerous smaller RBCs in IDA and thalassemia with suboptimal Hb levels. In other words, the RBC count is higher with respect to the Hb level which is reflected by a low MCH or hypochromia. In thalassemia, due to an additional hemolytic component (intramedullary hemolysis), the RBC count is even more higher than that seen in IDA. So MCH is much lower in BTT. (Z Score <= 1 – BTT).(Here we have confirmed all BTT cases through HPLC.)

➢ **Megaloblastic Anemia(MA) (Zmchc>Zmch, Z Score >2)**

Vit B12 deficiency leads to nuclear cytoplasmic maturation asynchrosy. Decrease in red blood cell count followed by decrease in hemoglobin because retarded nuclear maturation interferes with cell division and replication. This explains why anemia or pallor is not often seen in initial stages. As a result, MCH shifts towards right (Zmch>2) and can be considered as the first sign of B12/FA deficiency. In hemolytic types of MA (intramedullary hemolysis of dyspeptic erythroid precursors), the marrow attempts to compensate by regenerating more precursors but fails because of the ineffective erythroid maturation. Hence HCT is also low which shifts MCHC as well to the right (Zmchc>2) but Zmch>Zmchc because the B12/FA deficient RBCs are larger in size.

➢ **Hemolytic Anemia (Zmchc>Zmch)**

Various causes of haemolytic Anemia, leads to a reduction in both RBC count and HCT. Hb levels are unaffected. This leads to a right shift in MCH and MCHC such that Zmchc>Zmch. As regeneration is a process occurring in vivo, the difference 'Zmchc-Zmch' begins to decrease because there is stress reticulocytosis which can also be predicted by an increased RDW.

➢ **Anemia of Chronic disease (Zmchc>Zmch)**

The RBCs are usually normocytic and normochromic (ncnc) however hypochromia and microcytosis may be observed but is not as striking as in IDA.RDW may be normal or high but reticulocytosis is not usually observed .The three main causes associated with ACD are 1) shortened RBC life span. 2) impaired marrow response due to decreased EPO secretion by a diseased kidney or cytokines. 3) Disturbance in iron metabolism in which there is a predilection of shift in iron from a transferrin bound available state to a ferritin incorporated storage state in macrophages. This results in a decrease in both RBC count and Hb concentration, though the decline is not always proportional. As a result, MCH and MCHC keep oscillating near the mean value. This is why it can mimic many other conditions and the sensitivity of Z score is comparatively less.

CONCLUSION

We have examining peripheral blood smears of studied cases and compared with our statistically derived diagnosis. Case study is significant for Anemia of chronic disease, Hemolytic Anemia and Beta thalassemia trait. Iron Deficiency anemia and Megaloblastic anemia study is not significant; thus they are poor predictor. This will significantly save resources and decreases the turnaround time of reporting.Also reduces dependency on peripheral smear for interpretation of anemia. But the peripheral smear examination and bone marrow examination remain the gold standard for classification of anemia. Electrophoresis/HPLC is gold standard for diagnosing hemoglobinopathies and differentiating between IDA and BTT. Z score helps us in making quick interpretation of underlying red cell abnormality especially when there is no availability of clinical details of patient.

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