

SIGNIFICANCE OF HAEMOGLOBIN CONCENTRATION AND TOTAL LEUCOCYTE COUNT IN ASSESSING SEVERITY OF SICKLE CELL ANAEMIAIkeh Kanayo Eugene*¹, Damulak Obadiah Dapus², Azachi Williams Bitty¹¹Department of Medical Laboratory Science, Faculty of Medical Sciences, University of Jos, Nigeria. P.M.B 2084.²Department of Haematology and Blood Transfusion Science, Jos University Teaching Hospital, Nigeria.***Corresponding Author: Ikeh Kanayo Eugene**

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ABSTRACT

Sickle cell anaemia is the most common hereditary blood disorder in Africans. Most of the time, patients are in a steady state free of pain or infection. The disease becomes more severe in these conditions and patients are said to be in crisis. We measured the haemoglobin concentration and total leucocyte count of sickle cell patients to determine if these could be used as prognostic indicators of disease severity. We recruited 30 patients in steady state, 30 in crisis, and 30 age-matched controls with the haemoglobin AA genotype. Haemoglobin concentration was lower in sickle cell patients than the controls and total leucocyte count higher, confirming the chronic haemolytic process occurring and the predisposition to infection. Haemoglobin concentration was not significantly different between sickle cell patients in crisis and steady state in all the three age groups, ≤ 23 , 24-26, and ≥ 27 years (p-values 0.701, 0.382, 0.677 respectively). Total leucocyte count was higher in crisis patients in the ≤ 23 age group (p-value 0.008), but not significant in the other age groups. We conclude that haemoglobin concentration cannot be used to predict disease severity, however assessing leucocyte count could significantly reduce visits to the emergency room, at least for patients under 23 years.

KEYWORDS: Steady state, Crisis state, Haemoglobin, Total Leucocytes.**INTRODUCTION**

Sickle cell disease is a group of haemoglobin disorders in which the beta globin chain is abnormal in that at position 6 of both chains, glutamine has been replaced by valine. Homozygous sickle cell anaemia (Hb SS) is the most common while double heterozygote conditions of Hb SC and Hb S β thalassaemia also cause sickling disease.^[1] The sickle gene is particularly prominent in tropical regions endemic for malaria including Central and West Africa. These regions record high mortality rate, especially among children due to lack of newborn screening and treatment.^[2] Sickle cell crisis is a term used to describe several complications occurring in patients with sickle cell anaemia, the major complication being vaso-occlusion resulting acute or chronic multisystem damage.^[3] Majority of the patients are stable most of the time, free of pain, infection or any ongoing disease process and are referred to as being in the steady state.^[4]

Previous studies have established that sickle cell patients have low haemoglobin concentrations and packed cell volume in Nigeria due to the rate of chronic haemolysis going on in these patients.^[4-6] Leucocytes play an important role in the pathophysiology of sickle cell anaemia by adhering to blood vessel wall and

aggregating with other blood cells, thereby increasing luminal obstruction.^[7] In this study, we compared haemoglobin concentrations and total leucocyte count in sickle cell patients in crisis and steady state, in a bid to ascertain positive indicators of disease severity.

MATERIALS AND METHODS**Setting**

This study was carried out in Jos University Teaching Hospital (JUTH), Jos, Plateau State, Nigeria. Approval was granted by the Jos University Teaching Hospital Ethical Committee and verbal and written consent were obtained by all participants in this study.

Study Design

This was a controlled cross-sectional comparative study. The study population included sickle cell anaemia patients in steady state and in crisis state. A control population of age and sex matched Hb AA individuals were used.

90 EDTA anticoagulated blood samples were used: 30 sickle cell anaemia patients in crisis samples, 30 sickle cell anaemia patients in steady state samples and 30 Hb AA control samples.

Sample Analysis

Samples were analysed using Rayto RT-7200 Auto Hematology Analyzer (Rayto Life, China).

Data Analysis

Data were analyzed using SPSS version 16.0 (Statistical Package for Social Sciences, Inc., Chicago, III). The descriptive data were given as means \pm standard deviations. The Pearson chi squared test was used for analytic assessment and the differences were statistically significant when the p value obtained was < 0.05 . The haemoglobin concentrations and total leucocyte count of sickle cell anaemia patients (in crisis and steady state) were compared with those of their Hb AA counterparts (age-matched). Also, a comparison was made of the

haemoglobin concentration and total leucocyte counts between sickle cell anaemia patients in crisis and steady state.

RESULTS AND DISCUSSION

A total of 90 individuals were recruited into the study; 60 individuals were subjects confirmed to have haemoglobin SS genotype: 30 were in steady state while the remaining 30 were in crises. The control group consisted of 30 age-matched individuals who had the haemoglobin AA genotype. Table 1 summarises the demographic characteristics of the patients with respect to age and gender.

Table 1: Demographic characteristics of sickle cell anaemia patients and controls.

Parameter		Sickle Cell Anaemia Steady State (N=30)	Sickle Cell Anaemia Crisis State (N=30)	Control (N=30)
Sex	Male	15 (50%)	13 (43.3%)	14 (46.7%)
	Female	15 (50%)	17 (56.7%)	16 (53.3%)
Age (years)	Male	25 \pm 4	23 \pm 5	25 \pm 2
	Female	24 \pm 4	24 \pm 5	24 \pm 2

The mean ages of the sickle cell patients present a vague snapshot of the life expectancy of patients in Nigeria. Although the sampling technique used in this study was 'self-selection', the mean ages of the sickle cell patients were unintentionally skewed towards the twenties. Estimates show that about 100,000 people die each year from sickle cell anaemia in African countries alone and only 14% survive to adulthood^[8]. This can be attributed to the sub-optimal management of sickle cell disease patients in Africa. A study demonstrated a relatively good awareness of sickle cell disease in Nigeria.^[9] However, the neonatal screening program in Nigeria is

grossly underdeveloped, leading to late diagnosis and poor management of patients, especially considering the population of low-income individuals in the country.^[10]

The data represented in table 2 shows a comparison of haemoglobin concentration and total leucocyte counts in sickle cell anaemia crisis state with the controls in relation to age group, while that represented in table 3 compared the same parameters in sickle cell anaemia patients in steady state with their age-matched control counterparts.

Table 2: Hb and TLC in Sickle Cell Anaemia Crisis state and Controls in relation to Age Group at JUTH.

Parameter		Sickle cell anaemia crisis state (N=30)	Control (N=30)	P-value
Hb (g/dl)	≤ 23	8.49 \pm 2.26	12.56 \pm 1.16	0.000
	24-26	7.90 \pm 1.24	12.11 \pm 1.14	0.000
	≥ 27	8.31 \pm 2.68	13.90 \pm 2.13	0.002
TLC ($\times 10^9/L$)	≤ 23	14.76 \pm 8.52	5.30 \pm 1.64	0.001
	24-26	12.70 \pm 5.52	4.20 \pm 1.24	0.000
	≥ 27	11.56 \pm 6.28	4.85 \pm 1.54	0.028

Values are expressed as means and standard deviations

Results are significant at $p < 0.05$

Table 3: Hb and WBC counts in Sickle Cell Anaemia Steady State and Controls in relation to Age Group at JUTH.

Parameter		Sickle cell anaemia steady state (N=30)	Control (N=30)	P-value
Hb (g/dl)	≤ 23	8.81 \pm 2.33	12.56 \pm 1.16	0.035
	24-26	9.06 \pm 2.30	12.11 \pm 1.14	0.001
	≥ 27	8.82 \pm 2.11	13.90 \pm 2.13	0.001
TLC count ($\times 10^9/L$)	≤ 23	7.84 \pm 3.62	5.30 \pm 1.64	0.001
	24-26	8.40 \pm 2.94	4.20 \pm 1.24	0.000
	≥ 27	8.76 \pm 3.01	4.85 \pm 1.54	0.012

Values are expressed as means and standard deviations

Results are significant at $p < 0.05$

As illustrated in tables 2 and 3, the haemoglobin concentrations were generally lower in sickle cell anemia patients in crisis and steady states than haemoglobin AA controls while the white blood cell counts were generally higher than the control values in all the three age groups. Similar lower haemoglobin values were obtained in other studies.^[4,6] These results were expected considering the degree of chronic haemolysis, characterised by hypercellular bone marrow and red cells with a shorter life span. Most patients do well with low haemoglobin and haematocrit values between 20% and 25% and may

not need to treat anaemia with blood transfusion.^[11] Raising haematocrit to over 30% could, in fact, contribute to the sickling process by increasing viscosity, thereby increasing time in which cells remain in areas of circulation with low oxygen tension. The leucocytosis seen in both crisis and steady state cases may be in response to increased susceptibility to infections due to auto splenectomy from splenic vessel occlusions particularly from encapsulated organisms such as *Streptococcus pneumonia* and *Haemophilus influenza*.^[4]

Table 3: Hb and WBC counts in Sickle Cell Anaemia Crisis State and Sickle Cell Anaemia Steady State in relation to Age Group at JUTH.

Parameter		Sickle cell anaemia steady state (N=30)	Sickle cell anaemia crisis state (N=30)	P-value
Hb (g/dl)	≤23	8.81±2.33	8.49±2.26	0.701
	24-26	9.06±2.30	7.90±1.24	0.382
	≥27	8.82±2.11	8.31±2.68	0.677
WBC count (*10 ⁹ /L)	≤23	7.84±3.62	14.76±8.52	0.008
	24-26	8.40±2.94	12.70±5.52	0.120
	≥27	8.76±3.01	11.56±6.28	0.256

Values are expressed as means and standard deviations

Results are significant at $p < 0.05$

Table 3 shows a comparison of haemoglobin concentration and total leucocyte counts in sickle cell anaemia crisis state and sickle cell anaemia in steady state. There was no statistically significant difference in haemoglobin concentration of sickle cell anaemia patients in steady state and those in crisis in all age groups. Similar findings have also been reported.^[12] This may be due to the blunted response in erythropoietin secretion in sickle cell anaemia because of the lower affinity of the sickle haemoglobin (HbS), to oxygen when compared to normal adult haemoglobin (HbA),^[13] suggesting that haemoglobin concentration cannot be used to determine the severity of vaso-occlusive crisis. A statistically significant relationship could not be established in this study between total leucocyte count and frequency of pain in age groups 24-26 years and ≥27 years. However, a higher total leukocyte count was obtained in sickle cell patients in crisis when compared with steady state patients within the age bracket of ≤23 years. This shows that leucocytosis is a positive indicator of disease severity in this age group suggesting a chronic inflammatory process. This has also been demonstrated in other studies showing a positive relationship between increased leucocyte count and frequency of visits to the emergency room.^[14,15] Thus, strategies aimed at reducing the white cell counts in sickle cell patients could ameliorate the severity of the disease. Also, periodic monitoring of the leucocyte count of sickle cell patients could serve as an indication to an impending crisis and treatment can be initiated early to prevent a full-blown crisis.

CONCLUSION

Haemoglobin concentration was generally lower in sickle cell anaemia patients and total leucocyte count higher when compared to haemoglobin AA controls. Haemoglobin concentrations were not significantly different in sickle cell crisis patients when compared to steady state patients suggesting that haemoglobin values cannot be used to predict the severity of the disease. However, a significantly higher leucocyte count in crisis patients than steady patients under 23 years suggests that its periodic evaluation could serve as a prognostic marker for onset of crisis.

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