Original Research Article

ANALYSIS OF PROVIDER INITIATED SICKLE CELL DISEASE SCREENING IN MATHARE SLUMS, NAIROBI KENYA: A CASE OF GERMAN DOCTORS, BARAKA HEALTH CENTRE.

Abstract: -
Sickle cell disease (SCD) results in alteration of both hematological and biochemical parameters of the affected individuals. In Kenya, it is estimated that 4,000 children are born with SCD annually; about 21% of children in Kisumu are born with Sickle cell trait. Study objective was to analyze the screening of SCD using various screening techniques at German Doctors-Baraka Health Center in Mathare, Nairobi. On methodology, purposive sampling and cross sectional study design was employed among patients of all ages with clinical features suggestive of SCD. Data utilization permission was sought from hospital administration. Patients' January 2019 to May 2023 secondary data was extracted from the hospital's medical records and analyzed using SPSS version 21, the results were presented in percentages. The study found; comprehensive diagnostic approach of SCD facilitated screening of 2053 subjects. About 512 patients were screened by conventional "sickling test" using sodium metabisulphite, 791 by Sickle Cell Scan and 750 by electrophoresis method. Generally, among 2053 subjects screened, the positivity rate was 48.2%. Sickling test positivity rate was 45.9% and 49.1% positivity for Sickle Cell Scan. Sickle Cell Scan screened 791 (49.1%) subjects, and 39.32% of the 791 had homozygous while 9.73% of the 791 were heterozygous forms. Electrophoresis identified forms of sickle cell; with homozygous and heterozygous representing 38.8% and 10% respectively. It concludes that reliability of Sickle Cell Scan and HB electrophoresis are relatively the same based on almost similar rates in identifying true positive cases and the forms of sickle cell disease. The study recommends that clinicians capacity building on managing SCD is required.

Key terms: **Sickle cell disease, sickle cell screening, sickling test, slum, sickle cell scan, electrophoresis sickle cell diagnosis, electronic medical record**

Introduction

Sickle cell disease (SCD) is the most common severe monogenic disorder in humans and is characterized by presence of sickle shaped red blood cells in the blood(1). It is caused by the inheritance of two copies of the gene encoding hemoglobin S, a protein that results from a missense mutation in the β-globin subunit of hemoglobin A, or the co-inheritance of the gene for hemoglobin S and another abnormal or nonfunctional hemoglobin gene. Sickle cell disease results in the alteration of both hematological and biochemical

parameters of the affected individuals, resulting to erythrocytes being unstable, resulting to excessive hemolysis, and abnormal shape, leading to inflammation and vascular occlusion (2). There is paucity of population level data but in general, based on model projections it is estimated that almost 6,000 newborns (one in every 150 newborns) had Sickle Cell in 2010 and this number could rise to over 10,000 (one in every 100 newborns) per year by 2050. Morbidity and mortality have been high in young children with sickle cell disease(1). Universal screening and early intervention have significantly helped to reduce childhood mortality in high-resource countries. However, persons living in low-resource settings are often not diagnosed until late childhood when they present with clinical symptoms (2). However, recent studies have shown that early diagnosis and supportive care have significant impact in the reduction of complications, mortality and improved quality of life. The emphasis must now move towards early detection and prevention of long-term complications of sickle cell disease (1).

Diagnosis of SCD is based on clinical presentation, personal and family history, clinical features (signs/symptoms) and laboratory testing(1). The most common methods of screening include hemoglobin electrophoresis, isoelectric focusing (IEF), high-performance liquid chromatography (HPLC), and sickle solubility tests (Naik and Haywood, 2015). These tests all involve dried blood spots or whole liquid blood from a heel prick and check for red blood cell (RBC) count or hemoglobin variants(3). Sickling Test can be easily performed in a laboratory at lower level facilities. The test will be positive in individuals with Sickle Cell Disease as well as in Sickle Cell Trait. Hb separation technique is necessary once it is positive as it does not distinguish the different forms of SCD. This test should, however, NOT be used for screening newborns and is not advisable for children as it may give false negative results due to elevated HbF levels. The test is also of no added value if the blood film morphology shows Sickle Cells (1).

Electrophoresis is a classic method for identifying hemoglobinopathies; it uses an electric field to separate hemoglobins based on their charge. Further separation is possible by changing the pH and support medium. This method is the cheapest, but it is time and labor intensive(3). High Performance Liquid Chromatography both separate hemoglobin based on net charge on a gel medium at particular pH levels. It has rapid output and can be automated to run thousands of samples in minutes, however, HPLC is also cost intensive and requires high levels of technical expertise Because of issues with false positives and false negatives, confirmatory testing following the initial screening is generally required(1). Hemotype SC test was created using advanced, qualitative lateral flow technology using capillary blood to identify the presence of hemoglobin A, S, and C allowing for detection of results with the naked eye, use of venous blood demonstrated 99 % sensitivity and 99 % specificity for the diagnosis of HbSS, HbAS, HbSC, HbAC, and HbAA(2). Screening has long been recognized as an important tool for early disease detection , however, it remains important to exercise caution and judgment beforehand and to make sure that there are adequate resources for follow-up and treatment of the disease in focus (3).

Problem statement

Globally, it is estimated that Sickle Cell Disease (SCD) causes between 6-15% deaths in children aged less than 5 years. At least 240,000 children in Africa are born each year with Sickle Cell Disease of which an estimated 6,000 are in Kenya alone, the disease is common across Kenya with high disease burden pockets in Western, Nyanza and Coastal regions. A child born with Sickle cell disease is ten times likely to die than a normal child (1).

Study justification

In Sub-Saharan Africa, an estimated 50-90% of those born with the condition die undiagnosed before their 5th birthday. There is paucity of data in Kenya, but in general, malaria endemic areas have a higher prevalence of SCD(1). In the absence of screening and appropriate treatment, majority of such children die undiagnosed in early childhood from preventable causes such as malaria and bacterial infections. Interventions to control the disease include provision of prompt and effective management, advocacy, communication and social mobilization for screening and genetic counseling during premarital courtship. As Kenya rolls out one of its 'Big Four Agenda' on Universal Health Coverage and Sickle Cell Disease transitions from a condition that is

fatal in early life to a chronic condition needing life-long care hence requiring preparedness of our health services and this calls for employment of public health approach that necessitates population screening for sickle cell disease (1).

I. METHODOLOGY

Research Design

A retrospective cross sectional study design was used; purposive sampling technique was applied in recruiting 2053 participant to the study. Inclusion was based on examining clinician's clinical judgment among presumed sickle cell patients in search of medical care at German Doctors, Baraka Health center in Mathare slums, Nairobi Kenya. Study period was from January 2019 to May 2023, there was an annual change of the screening method and that eliminated chances of participant double registration. With acquisition of HB electrophoresis test, which is the gold standard technique for the diagnosis of sickle cell, there was a hospital drive to confirm patients' diagnosis attained through use of the earlier techniques. To avoid double entry of all retested patients were excluded from the study. Secondary data of various sickle cell screening methods (sickling test, HemoType SC, HB electrophoresis) was extracted from hospital's electronic health management information system (SANITAS) and entered into SPSS version 21 and presented in rates.

Study area

Mathare is the second largest slum in Kenya with a population of approximately 250,000 people(4). Mathare Valley is within Mathare area and is home to German Doctors Baraka Health center which a medical facility is offering various specialized clinics. It has the largest sickle cell clinic by patient volume in Mathare area if not Nairobi at large(5).

Data collection

The hospital uses electronic data management system, patient records from the laboratory is stored in cloud. Data is readily available for analysis upon request. Secondary data was extracted and entered into SPSS version 21 for analysis.

Data Analysis

Quantitative secondary data was extracted from the electronic data management system (SANITAS) and entered into SPSS version 21. Frequencies and rates were used to compare different diagnostic and screening procedures of Sickle cell disease. Data was presented in table and bar graph.

Ethical consideration

Permission to use hospital laboratory data was sought from the hospital administration. The researcher did not include names and ages of the participants in the study. Only data related to the various SCD screening test was included in the analysis. Data was well stored in computer folder and encrypted with a password.

II. RESULTS AND DISCUSSION

General Characteristics

Patients with clinical features and symptoms relating to sickle cell disease were sent to the lab for screening and diagnosis. In the process, 2053 participants were included for the study and screened using various screening techniques as shown in **Table 1**. Conventional "sickling test" using sodium metabisulphite 512 screened with 235 turning out to be positive, representing positivity rate of 45.9%. Hemo Type SC (sickle cell scan) was used among 791 patients with 388 of them turning out to be positive representing a positive rate of 49.1%. Lastly, HB electrophoresis was used to screen 750 individuals with 366 of them turning out to be positive hence representing a positive rate of 48.8%. These screening tests were carried out during a specific period of time by considering the growth of the clinic, such that the simple tests were carried out during the foundation years of the clinic, sophisticated test came with clinic maturity.

Table 1: Sickling tests provide response as bivariate data of either positive or negative.

(Source: Author)

Screening period	Type of test	Participant screened	Positive cases	Positive rate
Jan 2019 to Dec 2022	Sickling test	512	235	45.9%
Jan 2021 to April 2021	Sickle cell scan	791	388	49.1%
May 2021 to May 2023	HB electrophoresis	750	366	48.8%

As shown in **Figure 1,** Sickle cell scan (Hemo Type SC) had a 49.1 % (388 subjects) positive rate, of the total Sickle cell scan screened, 791 subjects representing 39.32% (311 subjects) had homozygous form while 9.73% (77 subjects) had heterozygous forms. The same applied to HB electrophoresis which is able to identify forms of sickle cell; with homozygous form being 291 patients and heterozygous being 75 patients, representing 38.8% and 10% respectively

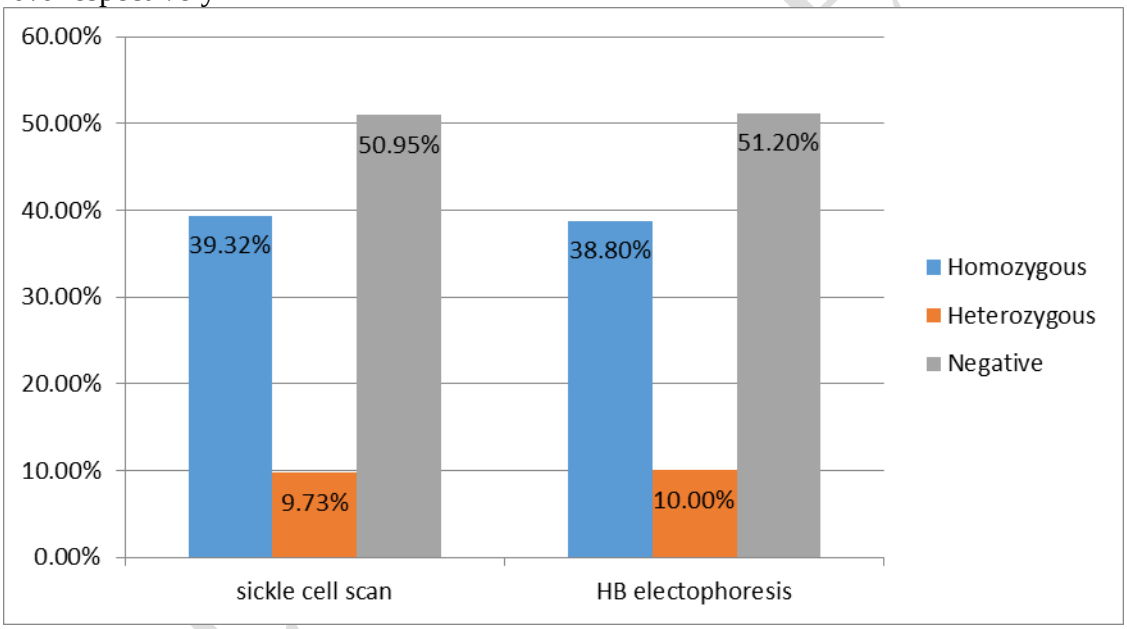

Figure 1: Bar graph showing forms of sickle cell disease as detected by sickle cell scan and HB electrophoresis. (Source: Author)

Discussion

The overall positivity rate in our study of all the sickle cell screening tests namely; sickling test, Hemo type SC and HB electrophoresis was 39.32% which is way far ahead of the recorded regional prevalence of 4.5% of children born with homozygous disease and 18% of those born with sickle cell trait (6). This difference can be attributed to the fact that a criterion of inclusion into the screening program was aided by clinical judgment of an experienced clinician who has been treating sickle cell patients for ages. Another reason could be due to the fact that there might have been false positive cases by the use of sickling test (7). Our study included participants of all ages as opposed to Wanjiku et al study that focused on new born and only relied on HB electrophoresis for screening and diagnosis(6).

Among those screened by Hemo type SC, the prevalence of hemoglobin S was at 49.1% which was higher than 15% found in a Côte d'Ivoire study which analyzed 236 children of all-comers (8). Again this high incidence in our study might have been contributed by clinicians clinical judgment and inclusion of subjects based on the medical examination. Interpretation of data also indicate more than 50% of false positives based

on clinical guideline which means in absence of diagnostic tests more patients would have been instituted into sickle cell management.

Conclusion

Combining clinical judgment and diagnostic tests is important in identifying true positive of sickle cell disease. Reliability of Hemo type SC and HB electrophoresis are relatively the same based on almost similar rates in identifying true positive cases and the forms of sickle cell disease. There was a tremendous growth of the sickle cell clinic at German doctors, Baraka health center due to an annual acquisition of latest diagnostic equipment and the multidimensional management of Sickle cell disease.

Recommendations

Human resource capacity building is advised on examination and diagnosis of sickle cell disease. Population screening for sickle cell is advised among individuals hailing from large water bodies and malaria endemic region. This will enable early identification and institution of management to mitigate negative effects of sickle cell disease. There is a need to mobilize funds by the Ministry and other stakeholders to equip healthcare facilities with proper diagnostic equipment especially in informal settlements engulfed with high burden of Sickle Cell Disease.

REFERENCES

1. Ministry of Health K. National Guidelines For Control And Management Of Sickle Cell Disease in Kenya. 2020;
2. Kanter J, Telen MJ, Hoppe C, Roberts CL, Kim JS, Yang X. Validation of a novel point of care testing device for sickle cell disease. BMC Med [Internet]. 2015 Sep 16 [cited 2023 Jul 13];13(1):1–8. Available from: https://link.springer.com/articles/10.1186/s12916-015-0473-6
3. McCormick M, Osei-Anto HA, Martinez RM. Addressing sickle cell disease [Internet]. Addressing Sickle Cell Disease. National Academies Press (US); 2021 [cited 2023 Jul 15]. 1–496 p. Available from: https://www.ncbi.nlm.nih.gov/books/NBK566461/
4. Habitat U. Informal settlements' vulnerability mapping in Kenya facilities and partners mapping in Nairobi; The Case of Mathare. 2020;1–24.
5. Owade VD. Sickle Cell Awareness [Internet]. 2022 [cited 2023 Jul 20]. Available from: https://germandoctorsnairobi.co.ke/sickle-cell-awareness/
6. Wanjiku CM, Njuguna F, Asirwa FC, Mbunya S, Githinji C, Roberson C, et al. Establishing care for sickle cell disease in western Kenya:achievements and challenges. Blood Adv [Internet]. 2019 Dec 12 [cited 2023 Jul 20];3(Suppl 1):8. Available from: /pmc/articles/PMC7034116/
7. Old J, Harteveld CL, Traeger-Synodinos J, Petrou M, Angastiniotis M, Galanello R. HAEMATOLOGICAL METHODS. 2012 [cited 2023 Jul 21]; Available from: https://www.ncbi.nlm.nih.gov/books/NBK190583/
8. Kakou Danho JB, Atiméré YN, Koné D, Yéo DD, Couitchéré L. Feasibility Study of the "hemoTypeSC" Test for the Rapid Screening of Sickle Cell Disease in Côte D'Ivoire. Adv Hematol. 2021;2021.

STUDY AREA MAP