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NEWBORN SCREENING FOR SICKLE CELL DISEASE AT KISUMU COUNTY HOSPITAL, KISUMU –KENYA

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ABSTRACT

Background: **Sickle cell disease(SCD), a hereditary blood disorder of the haemoglobin molecule, has been acknowledged by World Health Organization(WHO) as a major public health priority. Newborn screening(NBS) for SCD coupled with provision of comprehensive medical care has been associated with a significant reduction in related morbidity and mortality.**

Objectives: **To estimate the birth prevalence of Sickle Cell Disease (SCD) and trait (SCT), assess acceptability of NBS and determine factors that influence acceptability of NBS at Kisumu County Hospital(KCH), Kenya during the period between November 2015 to June 2016.**

Design: **Cross Sectional Study**

Setting: **The postnatal ward at the KCH which serves a population of about one million people with about 300 deliveries occuring every month.**

Results: **Data was collected from 1785 parents/guardians and 1810 new-borns (23 sets of twins and one set of triplets). There were 921 (50.9%) male new-borns. The parents/guardians were aged between 18 and 42 years (median 23 years), 11(0.6%) had no formal education, 1129 (63.2%) had heard about SCD but only 14(1.2 %) had ever been tested for SCD. Birth prevalence of SCD and SCT among the new-borns was 57(3.2%) and 250(13.9%) respectively. Almost all parents/caregivers, 1774(99.4%) accepted to have their new-borns screened. Among those who declined, 8 cited fear of the unknown as the main reason. All the parents/guardians who had no formal education and all those who had ever been**

tested for SCD before accepted NBS. Agreeing that SCD is preventable was the only statistically significant factor on bivariate and multivariate logistic regression analysis (OR 4.68, CI (1.15-19.17), P =0.014).
Conclusion: **NBS for SCD was highly acceptable. The birth prevalence of sickle cell disease and trait was high according to the WHO.**
Recommendations: **Implementation of routine NBS for SCD in Kisumu County and other high SCD prevalence regions in Kenya.**

INTRODUCTION

Sickle haemoglobin (HbS) is the commonest known single gene mutation in the world. (1) Sickle gene results from substitution of the amino acid Valine for Glutamate at the 6th position of the beta polypeptide chain of haemoglobin (2). Sickle haemoglobin HbS is inherited as an autosomal recessive allele. (3)

It is estimated that sickle cell disease may be responsible for 5% to 16% of under-five mortality in Africa (4). During the 63rd United Nations Annual Assembly held in December 2008, Sickle Cell Disease (SCD) was recognised as a public health problem and member states were urged to raise awareness and implement appropriate strategies for its control. (4). New-born screening for SCD to identify the affected children early, direct them to relevant comprehensive clinics where appropriate medical care is started at an early age of two to three months has been recommended by WHO as one of the main strategies to reduce related morbidity and mortality. (5.6).

The WHO estimates a 70% reduction in SCD related mortality if new-born screening with subsequent provision of comprehensive care program is adopted in African countries(2,7,8,9).

In Kenya, NBS programs for SCD have not yet been adopted. The purpose of this study was to provide information on acceptability of prevalence of SCD and to assess factors that influence acceptability of NBS as well as provide an estimate of the prevalence of SCD and SCT among new-borns delivered at KCH. This will inform the relevant authorities of the burden and assist in formulating appropriate health programs to facilitate early diagnosis and provision of comprehensive care.

MATERIALS AND METHODS

The study population was the parents /guardians with their new-borns aged between 0 and 72 hours delivered at a gestation of more than 30 weeks during the period between November 2015 to June 2016 at Kisumu County Hospital (KCH) where approximately 300 deliveries occur each month and serves a population of about 968,909 people.

Afetr informed consent was obtained, an interviewer administered questionaire was used to collect demographic data, parent/caretaker's awareness of and knowledge about SCD and whether the parent/guardian accepted or declined to have his/her newborn screened.

Dried blood spots for the screening test were collected by a heel-prick under sterile conditions from eligible newborns, stored in a lockable cabinet within the hospital's laboratory and later transported to the AMPATH (Academic Model for Providing Access To Health Care) reference laboratories at the Moi Teaching and Referral Hospital (MTRH), Eldoret for analysis by Iso Electric

Focussing(IEF) and the results later relayed to the participant's guardian/parent.

Data obtained was entered into an Excel ® sheet, cleaned and analysed. Descriptive statistics were used to assess participants' characteristics. Quantitative data was analysed using a computer program, Statistical Package for Social Sciences (SPSS) version 22.0 at 95% confidence interval. Logistic regression analysis was used to test for independent associations. Values less than 0.05 was considered to be statistically significant.

RESULTS

Data was collected from 1785 parents/guardians and 1810 new-borns (1761 singletons, 23 sets of twins and one set of triplets). There were 921 (50.9%) female and 889 (49.1 %) male new-borns.

Table 1 shows that 907 (50.8%) of the respondents were aged between 20 and 25 years, 406 (25.6 %) aged between 26 and 30 years, 253 (14.2 %) below 20 years and 165 (9.2%) above 30 years. Table 1 also shows that 809 (45.3 %) of the respondents had secondary education, 706 (39.6%) primary education, 259 (14.5%) college /university education while 11 (0.6%) had no formal education.

Table 1

Demographic Characteristics of the Respondents

Age	**Frequency (n=1785)**	**Percent**
Below 20 years	253	14.2
20-25 years	907	50.8
26-30 years	460	25.8
Over 30 years	165	9.2
Total	1785	100
Education Level	Frequency(n=1785)	Percent
No formal education	11	0.6
Primary	706	39.6
Secondary	809	45.3
College/University	259	14.5
Total	1785	100

Table 2 shows that 1129 (63.2 %) of the respondents were aware of SCD out of which 396 (35.2%) had heard about it while in school, 313 (27.8%) from neighbours, 187 (16.7 %) from TV/radio, 101 (9.1%) from a health work and less than 6% from other sources. Regarding how people get SCD, 444 (39.2%) indicated that they did not know, 616 (54.6%) through inheritance, 38(3.4%) through infection, 11 (1.0) through poor sanitation and others.

Table 2 also shows that 482 (42.7%) of the respondents who were aware of SCD did not know how it is diagnosed, 577 (51.1%) indicated that it can be diagnosed through a blood test , 24 (2.1%) through a combination of symptoms and blood test while the rest gave other different responses. Only 14 (1.2%) of those who were aware of SCD had ever been tested.

Table 2 also shows that 665 (58.9 %) of those who were aware of SCD knew of someone

with SCD, 437 (38.8%) indicated that they do not know whether SCD is curable, 397 (35.0%) indicated that it is not curable while 297 (26.3%) indicated that SCD is curable. On whether SCD is preventable 591 (52.3%) indicated that it is preventable, 423 (37.5%) indicated that they did not know while 116 (10.2%) indicated that it is not preventable.

Table 2
Information on SCD

Ever heard of/ aware of SCD?	**Frequency (n=1785)**	**Percent**
Yes	1129	63.2%
No	656	36.8%
Total	1785	100%
How did you know of SCD?	Frequency (n=1129)	Percent
School	396	35.2%
Neighbors	313	27.8%
TV/Radio	187	16.7%
Health Worker	101	9.1%
Family	66	5.9%
Friend	36	3.3%
Newspapers/magazines	9	0.2%
Others	21	1.9%
Total	1129	100%
How do people get SCD?	Frequency (n=1129)	Percent
Inheritance	616	54.6%
Infection	38	3.4%
Poor Sanitation	11	1.0%
Contact	1	0.1%
Don't Know	444	39.2%
Others	19	1.7%
Total	1129	100%
How is SCD diagnosed?	Frequency (n=1129)	Percent
Blood Test	577	51.1
Blood test & symptoms	24	2.1
Urine Test	14	1.2
Stool Test	8	0.7
Radiological Imaging	15	1.3
By symptoms	5	0.5
Others	4	0.4
Don't Know	482	42.7
Total	1129	100

Ever been Tested for SCD?	Frequency(n=1129)	Percent
Yes	14	1.2
No	1115	98.8
Total	1129	100
Know anyone with SCD	Frequency(n=1129)	Percent
Yes	665	58.9
No	464	41.1
Total	1129	100
Is SCD curable?	Frequency(n=1129)	Percent
Yes	297	26.3
No	395	35.0
Don't know	437	38.7
Total	1129	100
Is SCD preventable?	Frequency(n=1129)	Percent
Yes	591	52.3
No	116	10.2
Don't know	423	37.5
Total	1129	100

Table 3 shows that 1785 (99.4%) of the respondents accepted to have their new-borns screened for SCD while 11 (0.6%) declined with 8 of them citing fear of the unknown.

Table 3
Acceptability of New-born Screening

Accept NBS	**Frequency(n=1785)**	**Percent**
Yes	1774	99.4
No	11	0.6
Total	1785	100
Reasons for Non-acceptance	Frequency(n=11)	Percent
Fear of the unknown	8	72.8
May cause marital conflict	2	18.1
Others	1	9.1
Total	11	100

Table 4 shows that 11 (100%) respondents who had no formal education, 705 (99.9%) with primary and 1058 (99.0%) with secondary/college /university accepted to have their new-borns screened, The acceptability of NBS decreased with higher levels of education.

Table 4

Cross tabulation of level of Education versus Acceptability of NBS

		Accept NBS (n=1785)		**Total**
		Yes	**No**	
Respondent's level of Education	No formal education	11 (100%)	0 (0.00%)	11
	Primary	705 (99.9%)	1(0.10%)	706
	Secondary/ College/University	1058 (99.0%)	10 (1.0%)	1068
Total		**1774(99.4%)**	**11(0.6%)**	**1785(100%)**

Table 5 shows bivariate logistic regression analysis of factors associated with acceptability of new-born screening of SCD.

Table 5

Bivariate logistic regression

Variable		**Accepted NBS**		**P value**
		Yes	**No**	
Knows/heard of SCD	Yes	1,119/ 1,129(99.1%)	10/1129 (0.9%)	0.321
	No	655/656(99.9%)	1/656 (0.1%)	
Knows how SCD is diagnosed	Yes	613/621 (99.7)	8/621 (0.3%)	0.133
	No	506/508(99.6%)	2/508 (0.4%)	
Tested for SCD before	Yes	14/14(100%)	0/14	Omitted
	No	1,105 /1,115(99.0%)	10/1115(0.9%)	
Knows patient with SCD?	Yes	657/665 (99.8%)	8/665 (0.2%)	0.20
	No	462/464 (99.6%)	2/464 (0.4%)	
Is SCD curable?	Yes	295 /297 (99.3%)	2/297 (0.7%)	0.64
	No	391/395 (99.0%)	4/395 (1.0%)	
	Don't know	433/437 (99.1%)	4/437 (0.9%)	
Is SCD preventable?	Yes	587 / 591 (99.3%)	4/591 (0.7%)	0.014
	No	112/116 (96.6%)	4/116 (3.4%)	
	Don't know	421/423 (99.5%)	2/423 (0.5%)	

Table 6 shows that agreeing that SCD is preventable was the only statistically significant factor that influenced acceptability of NBS on multivariate analysis.

Table 6

Multiple Logistic Regression

Variable	Adjusted OR	P value	95% CI
Agree SCD is Preventable	4.68	0.014	1.15 - 19.17
Know patient with SCD	0.9	0.91	0.17 - 4.74
Know how SCD is diagnosed	0.3	0.85	0.05 - 3.35

Table 7 shows that 1491 (83 %) of the new-borns had normal haemoglobin (Hb AF), 250 (13.8%) had Sickle Cell Trait (Hb FAS), 1(0.1%) had haemoglobin C Trait (Hb FAC) and 57 (13.8%) had Sickle Cell Disease (Hb SF).

Table 7

Birth Prevalence

Result	Frequency (n= 1810)	Percentage
Hb AF (normal)	1491	83.0%
Hb FAS (sickle cell trait)	250	13.8%
Hb SF (sickle cell disease)	57	3.1%
Hb FAC (hemoglobin C trait)	1	0.1%
TOTAL	1799	100%

DISCUSSION

The findings of this study show that the birth prevalence of sickle cell trait (SCT) is within the estimated range (10 to 40 percent) in African region found between latitudes 15^0 North and 20^0 South. Our findings on the prevalence of Sickle Cell Disease(SCD) is however higher than the expected less than 2 percent.[5]

The results in this study are comparable to a similar study in Nigeria where out of 644 new-borns screened ,485 (75.3%) were HbAA, 133 (20.6%) were HbAS,, 7(1.1%) were HbAC, 18 (2.8%) were HbSS, and one (0.2%) was HbSC.[10] The similarity could be because both studies were hospital based and were done in areas within malaria endemic areas.

The birth prevalence results in this study were higher than in a similar study done at the Moi Teaching and Referral Hospital (MTRH), Kenya, where birth prevalence of SCD was 0.12% and SCT was 2.62% .[11]. The difference can be explained by the study settings; whereby majority (86%) of participants in the MTRH study were from Uasin Gishu County which is located in the malaria non-endemic region.

Our study found a higher prevalence of SCD compared to the findings in a surveillance study done in Uganda in which Isoelectric focussing was done on 99, 243 dried blood spots collected for HIV Polymerase Chain Reaction (PCR) in HIV exposed infants aged below 18 months. The prevalence of SCT was 13.3% and of SCD was 0.7%.[12] The similarity in the prevalence of SCT may be due to both studies having been carried out in high SCD prevalence areas in East Africa. The lower prevalence of SCD could be due to the inclusion of older children populations in the study, therefore attrition due to HIV – SCD comorbidity resulting in the loss of these children earlier in life.

A study which was conducted in maternity units in Rwanda, Burundi and the Democratic Republic of Congo and recruited 1825 new-borns found a birth prevalence of SCD and SCT of 0.11% and 3.23% respectively.[6] These findings are lower than those in this study and is likely to be due to the variation in prevalence among populations across Africa.

In a pilot program on new-born screening for SCD conducted in two large hospitals in Angola, 36, 453 infants were screened using IEF test; 77.31% were normal, 21.03% were carriers, 1.51% sickle cell disease and 0.019% were FSC. The study cited contact and retrieval of affected infants as a major challenge.[13] A pilot study by Tshilolo et al in Democratic Republic of Congo found a birth prevalence of SCD and SCT to be 1.4% (428) and 16.9%(5,276) respectively after screening 31,204 new-borns using IEF.[8] The above studies found varying birth prevalence of SCD and SCT as compared to the findings in this study, which can be explained by the different regions where the studies were carried out as prevalence differs among populations.

There are very few published studies on acceptability of NBS for SCD. In this study a very small percentage of the parents/guardians declined NBS. The reasons given for declining are comparable to the findings of a study conducted in MTRH, Eldoret, Kenya where the main reasons for declining included the need for new-born's father's consent for the test, lack of family history of SCD and fear of pain being inflicted on the new-born among other reasons.

The MTRH study found a lower acceptability (85%) for NBS as compared to our study [10]. The difference can be explained by the fact

that the catchment area for MTRH is mainly in low malaria prevalence zone and also a probability that most care givers approached had not interacted with SCD patients or were not aware of the disease, hence did not perceive the NBS to be beneficial thus taking the 'health belief model' into consideration. This study's set up was a high SCD prevalence and most of the parents/guardians were aware of SCD or had interacted with an affected person and therefore perceived the test as beneficial.

In a study conducted at St. Philomena's Hospital, Benin City, Nigeria in which 630 mothers/caretakers of 649 new-borns were approached to have them screened, only two declined, therefore acceptability of NBS for SCD was 99.7% [11], which is similar to the findings in our study. The high acceptability was attributed to health education that is offered in secondary schools in Nigeria that encompasses SCD, therefore, better understanding of the disease. Acceptability of NBS for SCD in our study could be attributed to the fact that the test was being offered by a clinician, therefore a mother/caregiver who was approached was more likely to accept based on the trust accorded to the clinician.

Among the demographic factors analysed, level of education was found to be inversely related to acceptability of NBS with those who had attained higher education levels being more likely to decline than those who had no formal education. Contrary to our study, higher levels of education have been associated with higher acceptability, attributed to a better understanding of the disease and the benefits of screening. [14]

Contrary to this study, in a retrospective study on parental decision making and new-born screening, parents/guardians were likely to accept NBS when offered by a clinician or midwife because of the trust they had in the health care worker regardless of the knowledge they (parent/guardian) had on the disease. [15]

A study carried out on an African-American population, found that a higher than average knowledge of SCD was significantly associated with one's interest in being screened.[16] In our study, there was no statistically significant difference in acceptability of NBS for SCD between the parents/guardians who were aware of SCD and those who did not know about SCD. The difference can be explained by the methodology whereby in the Shanna et al study, the participants were assessed initially, then taken through health education, then reassessed while our study concentrated on the respondent's baseline knowledge.

Knowledge of how SCD is diagnosed, whether it is inherited and whether curable or preventable were among the factors analysed by logistic regression on their influence on acceptability. There was no statistically significant difference in acceptability between the groups that had the correct information and those who did not know for all variables except for agreeing that SCD is preventable. Both bivariate and multivariate logistic regression analysis showed that the respondents who agreed that SCD is preventable were five times more likely to accept NBS than those who did not agree or did not know whether it is preventable or not. This could be explained by the fact that some of the parents/guardians thought that the disease if detected by NBS could be treated and cured.

All the respondents who had been tested before and 99.1% of those who had never been tested before for SCD agreed to have their new-borns screened. The findings are similar to a study conducted on African American women in which participants who

had undergone previous genetic testing demonstrated better acceptance for screening because they had more information following education on the disorder prior to screening. (16)

There was no statistically significant difference in acceptability of NBS for SCD between parents/guardians who knew of a patient with SCD and those who had never encountered any. In our study, most of those who knew of someone with SCD reported that the patient had died or was always in hospital. A study conducted among African American population also noted that it is possible that persons who had a personal experience with SCD, including afflicted family members or friends and had witnessed the severity of the disease, were more likely to feel that screening is beneficial. (16)

With such a high prevalence of both SCD and SCT in this study, many affected children, up to 90%, could lose their lives before attaining five years of age if no proper health infrastructure and comprehensive clinics are available for this population(3). This information is expected to inform policy on implementation of NBS for SCD and assist in the set-up of comprehensive care centres for SCD in Kenya.

CONCLUSION

The birth prevalence of SCD and SCT among new-borns delivered at the Kisumu County Hospital during the study period was high according to WHO standards. NBS for SCD was highly acceptable among parents/guardians of new-borns delivered at Kisumu County Hospital. Agreeing that SCD is preventable increased one's odds of accepting new-born screening for SCD. We recommend that routine NBS for SCD should be introduced in the study region.

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