

Neonatal glucose-6-phosphate dehydrogenase (G6PD) deficiency in Niamey

Mounkaila B^{1*}, Daouda A¹, Garba Rm¹, Aridouane D²

MOUNKAILA Boutchi, Hematology, applied biologic science department, Faculty of Health Sciences, Niamey.

ALHOUSSEINI Daouda, Biochemistry, applied biologic science department, Faculty of Health Sciences, Niamey.

GARBA R. Madeleine, gynecologist-obstetrician, department of Surgery, Faculty of Health Sciences, Niamey.

ARIDOUANE Diariétou, gynecologist-obstetrician, Issaka Gazobi Maternity, Niamey.

Abstract— G6PD deficiency is a hereditary enzymopathy linked recessive X which can cause chronic or acute hemolytic anemia with severe jaundice risks. Knowledge of this profile very early at birth will have the effect of reducing morbidity and neonatal mortality. The objective of this study was to determine the prevalence of this deficiency in newborns in Niamey through a cross-sectional descriptive study. G6PD intra erythrocyte of umbilical cord blood was measured by spectrophotometry at the same time as the intra erythrocyte ASAT that was used to estimate the age of the erythrocytes. Two hundred four neonates including 113 male (55.5%) and 91 female (44.5%) were enrolled. The overall prevalence of deficit was estimated at 11.80%. The partial deficit represented 10.3% against 1.5% for the total deficit. The G6PD activity was on average 4.11 ± 0.4 UI / g Hb whereas it was 1.7 ± 0.2 U / g Hb in newborns totally deficit and $24, 30 \pm 1.2$ U / g Hb in newborns without G6PD deficiency. The report G6PD / ASAT in newborns fully and partially deficit were 0.30 and 0.80 respectively. Hb levels in all three groups have no significant difference. The high prevalence of G6PD deficiency in the newborn population justifies the establishment of early screening at birth.

Keywords—G6PD deficiency, neonatal, umbilical cord blood, Niamey

I. INTRODUCTION

Glucose-6-phosphate dehydrogenase (G6PD) is the enzyme that protects against oxidative stress which distorts hemoglobin, membrane proteins and lipids, hence red blood cell lysing with the occurrence of acute or chronic severe anemia. The relevance of this enzymopathy lies in its high prevalence in some communities and its potential seriousness particularly in newborns where the clinical picture is particularly serious with the occurrence of neonatal jaundice or acute renal failure. Niger is a sub-Saharan country where the incidence of this enzymopathy is high [1]. Neonatal screening decreases neonatal morbidity and mortality and also facilitates therapeutic options.

II. PATIENTS AND METHODS

1) Study type and period

This 10 month long prospective cross-sectional study will be conducted at Issaka Gazobi Maternity in Niamey.

2) Sampling

Estimated at 15.7% [2], prevalence of G6PD deficiency in blood donors was used to calculate the minimum of the sample by applying the following formula: $(\delta^2 \times P \times Q/I^2)$ [3]. Cord blood was collected after full-term normal vaginal delivery ranging between 38 and 42 weeks. The sample would be selected as deliveries occurred.

3) Variables under study

Variables under consideration include: consanguinity among parents, hemoglobin level, reticulocyte rates, and blood cord intra erythrocytic G6PD activity.

4) Blood sampling

Whole blood is collected from blood cord into a EDTA tube for the purpose of complete blood count (CBC), reticulocyte count, determination of intra erythrocytic G6PD and determination of intra erythrocytic AST.

Hematologic parameters were measured using «Cell dyn 1800» type automated cell counter of Abbott diagnostics.

5) reticulocyte count

Reticulocytes are manually counted by microscope in thin smears obtained following blood incubation with brilliant cresyl blue, 1%, for 30 minutes.

6) Determination of G6PD and intra erythrocytic ASAT

Packed red blood cells are washed 3 times with physiological water before hemolysis. G6PD and intra erythrocytic AST activities were determined spectrophotometrically at 340 nm using BIOREX Diagnostics Limited (UK) reagents on the hemolysates obtained. Tests were conducted in conformity with the instructions provided by the manufacturer of reagents.

7) **Data analysis**

Chi-square test was used to compare proportions and the significance threshold was set at $p < 0.05$

8) **Ethical considerations**

The study was approved by the National Ethics Committee and is clear of conflicts of interest. Women involved in this study gave their informed consent

III.RESULTATS

During the study period, 2,131 women were admitted for labor, including 670 cases of normal vaginal delivery, 990 cases of delivery by Caesarean section and 328 cases of abortion. 143 women had to quit after premature delivery threats had been addressed and never came back to MIG. Thus, the study sample included 204 newborns (113 males (55.5%) and 91 females (44.5%)) and rate of consanguineous marriage among parents of the newborns was 31% (Figure1).

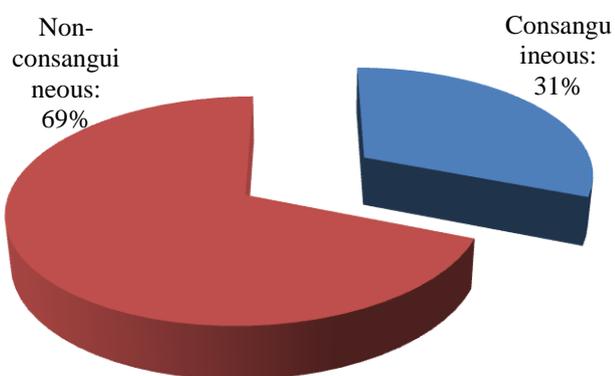


Figure 1: Consanguinity among parents of newborns

In our sample, hemoglobin varied from 120 and 195g/l with an average rate of 155 g/l ± 0.12 . Only 23.5% of newborns had hemoglobin below or equal to 140 g/l (figure 2).

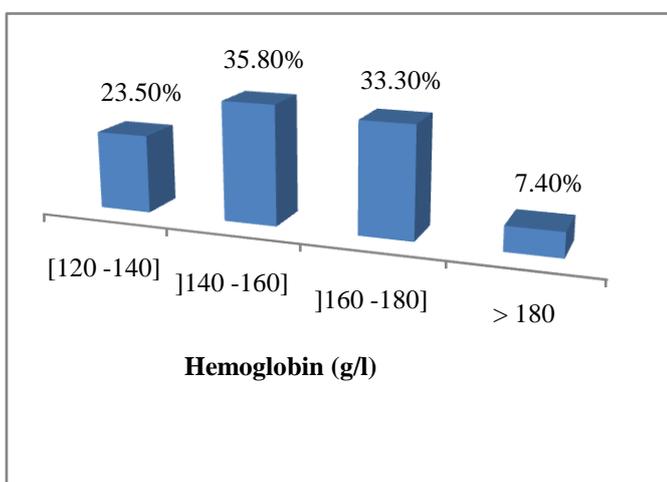


Figure 2: Distribution of hemoglobin

Mean corpuscular hemoglobin concentration (MCHC) was 33.5 % ± 0.2 and MCH was 34pg/l ± 0.2 . The average reticulocyte rate is 236, 000/ μ l , i.e. 5.57 ± 0.19 %.

G6PD deficiency was found in 24 newborns, i.e., an overall prevalence rate of 11.80% in the sample analyzed; partial and total deficiency rates stood at 10.3% and 1.5% respectively.

In partially deficient newborns, G6PD activity was on average 4.11 ± 0.4 U/g Hb, whereas it was 1.7 $\pm 0,2$ U/g of Hb in totally deficient newborns against 24.30 ± 1.2 U/g Hb in newborns with no G6PD deficiencies. G6PD/AST ratio in totally and partially deficient newborns was 0.30 and 0.80 respectively (Table I).

Table I: Distribution of the sample according to G6PD activity

		Total deficient (1.5%)	Partial deficient (10.3 %)	Normal subjects (88.2%)
G6PD (U/g Hb)	Extreme values	1.39 – 2.19	2.23 - 6.78	7.37 - 88.81
	Mean	1.7 ± 0.20	4.11 ± 0.40	24.30 ± 1.25
AST (U/g Hb)	Extreme values	3.3 - 10.34	1.5 - 12.20	0.24 – 41.51
	Mean	5.54 ± 2.40	5.12 ± 0.70	6.25 ± 0.31
G6PD/AST values	Extreme values	0.13 – 0.73	0.23 - 2.97	0.5 – 76.81
	Mean	0.30	0.80	3.80

Normal hemoglobin levels in newborns were 155.30 ± 0.13 g/l against 152.90 ± 0.30 g/l in partially deficient newborns and 151 ± 0.70 g/l in totally deficient newborns. There are no significant gaps.

IV.DISCUSSION

This study was conducted at Issaka Gazobi Maternity (MIG), the national reference center of gynecology, obstetrics, and neonatal care. A total of 2,131 women were admitted in this center for labor during the study period. 1660 deliveries were conducted, including 670 normal vaginal deliveries, 990 deliveries by Caesarean section. Cord blood was collected during vaginal deliveries. 204 full-term infants ranging between e 38 and 42 weeks of amenorrhea were recorded, including 113 male infants (55.5%) and 91 female infants (44.5%). Infants born in consanguineous marriages represented 31%. As shown by some studies, the high rate of consanguinity within households is common phenomenon in some locations, especially in Africa.

In Morocco, such a rate seems quite high, up to 40% within households [4]. In Bamako and in Niamey, it was found that 23.4% and 21% respectively of blood donations were from consanguineous parents [2, 5]. In our sample, hemoglobin varied from 120 to 195g/l with an average level of $155 \text{ g/l} \pm 0.12$. Such findings were similar to those reported in Saudi Arabia by Ahmed Muzaffer M [6] with Hb level varying from 140 to 190 g/L and an average level of 159g/L. overall neonatal deficiency was estimated at 11.80 %. This finding confirmed the high level of G6PD deficiency already recorded at the national blood transfusion centre where prevalence in blood donors was 15.7% [2]. Similar findings were reported by Olatundun et al [7] with a prevalence of 15.3% in Nigerian children aged between 1 month and 15 years and by Ratika et al [8] in India with 10.1%. High levels were observed in regions where Black communities migration is high, including the USA [9, 10] with respectively 11.1% and 12.8% of cases of neonatal deficiency and Marseille (France) [11] with 7% of all forms of deficiency.

10.3% of deficient patients recorded were partially deficient and 1.5% were totally deficient. Mean values of G6PD activity were $1.7 \pm 0.20 \text{ U/g Hb}$ for totally deficient patients and 4.11 ± 0.40 for partially deficient patients against $24.30 \pm 1.25 \text{ U/g Hb}$ in normal patients with no G6PD deficiencies. G6PD/AST ratio was lower in deficient infants compared to those with no deficiencies. Intra erythrocytic AST determination is justified as cord blood is very rich in erythroblasts and reticulocytes the latter may hide actual G6PD deficiency. Determination of its activity will therefore age red blood cells and make it possible to risks related to manual preparation of hemolysate [11].

G6PD deficiency is a factor that can aggravate the occurrence of hyperbilirubinemia in newborns with a risk of severe neonatal jaundice [12, 13]. According to the American Academy of Pediatrics, G6PD deficiency is the main cause of no immunologic neonatal hemolysis associating total hyperbilirubinemia and neurological dysfunction [14]. According to Raicevic et al [15], there is a correlation between oxidative stress and G6PD activity in newborns with no jaundice. In case such infants are premature, high oxidative stress which is likely to result in fatal risk which could only be rapidly addressed by phototherapy and transfusion exchange to save the lives of such children [16].

V. CONCLUSION

The prevalence of neonatal G6PD deficiency recorded in the maternities of Niamey is quite high (11.80%). Such a prevalence coupled with the prevalence of malaria, sickle cell disease and infections justifies the implementation of early G6PD screening as from birth.

Conflict of interest:

The authors declare no conflict of interest regarding this article.

Acknowledgement

The authors would like to thank the staff of Issaka Gazobi Maternity in Niamey for their exemplary cooperation.

REFERENCES

- [1] WHO working group. Glucose-6-phosphate dehydrogenase deficiency. Bull World Health Organ 1989; 67: 601–11
- [2] Moumouni Sina A. Déficit en G6PD chez les donneurs de sang du Centre National de Transfusion Sanguine de Niamey. Thèse Med. Université Abdou moumouni Niamey 2013
- [3] Ancelle T. Statistique épidémiologie 3ème Ed, Maloigne 2012
- [4] Mohamed SI. Déficit en G6PD chez les enfants au sein du service de pédiatrie du CHU Hassan II de Fès. Thèse méd. 2007
- [5] Diawara A. Déficit en G6PD chez les donneurs de sang du CNTS de Bamako. Thèse ph. Université de Bamako. 2005
- [6] Ahmed Muzaffer Mohammed. Neonatal screening of glucose-6-phosphate dehydrogenase deficiency in Yanbu, Saudi Arabia. J Med Screen 2005;12:170–171
- [7] Olatundun Williams, Daniel Gbadero, Grace Edowhorhu, Ann Brearley, Tina Slusher, Troy C. Lund. Glucose-6-Phosphate Dehydrogenase Deficiency in Nigerian Children. PLoS ONE 8(7): e68800. doi:10.1371/journal.pone.0068800
- [8] Ratika S, Mondal PR, and Saraswathy K N. Glucose-6-Phosphate Dehydrogenase Deficiency and Sickle Cell Hemoglobin among the Warli Tribe of Dadra and Nagar Haveli. Anthropologist, 2008, 10(4): 301-303
- [9] Nockl ML, Johnson EM, Krugman RR, Di Fiore JM, Fitzgerald S, Sandhaus LM, and Walsh MC. Implementation and analysis of a pilot in-hospital newborn screening program for glucose-6-phosphate dehydrogenase deficiency in the United States. Journal of Perinatology.2011 31, 112–117
- [10] Kaplan M, Hersche M, Hammerman C, Hoyer JD, Stevenson DK. Hyperbilirubinemia among African American, glucose-6-phosphate dehydrogenase-deficient neonates. Pediatrics 2004;114(2):213-9.
- [11] Kaddari F, Sawadogo M, Sancho J, Lelong M, Jaby D, Paulin C et al. Neonatal screening of glucose-6-phosphate dehydrogenase deficiency in umbilical cord blood Ann Biol Clin. 2004 Jul-Aug;62(4):446-50.
- [12] Kaplan M, Hammerman C. Glucose-6-phosphate dehydrogenase deficiency: a hidden risk for kernicterus. Semin Perinatol 2004; 28:356-64
- [13] Abu Omar R, Algur N, Megged, Hammerman C, and Kaplan M. Glucose-6-Phosphate Dehydrogenase Screening in Israel-Arab and Palestinian-arab neonates. J Pediatr 2015;167:169-72.
- [14] Ronald J. Wong, David K. Stevenson. Neonatal hemolysis and risk of bilirubin-induced neurologic dysfunction. Seminars in Fetal & Neonatal Medicine 2015: 20 26-30
- [15] Raicevic S, Eventov-Friedman S, Bolevich S, Selakovic D, Joksimovic J, Djuric J et al. Correlation between oxidative stress and G6PD activity in neonatal jaundice. Mol Cell Biochem. 2014 Oct; 395(1-2):273-9
- [16] Dhillon AS, Darbyshire PJ, Williams MD, Bissenden JG. Massive acute haemolysis in neonates with glucose-6-phosphate dehydrogenase deficiency. Arch Dis Child Fetal Neonatal 2003;88: 534–6