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"Glucose 6-Phosphate Dehydrogenase Enzyme Deficiency among Infants: An Eye Opener to Parents and would be Parents"

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Abstract. This paper tackles the historical background of G6PD/Favism, its function in glycolysis, and its blood genetics. It also encompasses how it is diagnosed, symptoms of G6PD deficiency attack, preventive measures & treatment. The aim of this paper is to provide parents of G6PD Enzyme Deficiency child a basic and scientific explanation how this metabolic deficiency happens and how its attack could be prevented. To would be parents this will serve as eye opener in case such deficiency will happen in their family

Keywords: Identify, describe G6PD Enzyme Deficiency. Determine how G6PD Enzyme Deficiency positive person cope up with this metabolic deficiency

1. Introduction

1.1. Background of the Study

Marriage is a lifetime commitment. One has to foresee the next generation. Some individuals do some research by tracing the historical background of their fiancée. One of the reasons is to forecast the inherited traits that could be transferred to their offspring. Some couples may resort to genetic counseling. However genetic mutation is inevitable. Gene mutation is one of the principal kinds of mutation. There are many gene mutations that occur in human and one of these is glucose 6 phosphate dehydrogenase enzyme deficiency. There are some measures to detect the metabolic disorder that a child could inherit from his/her parents. This is the newborn screening test. This test could detect some metabolic disorders such as CH (Congenital Hypothyroidism), CAH (Congenital Adrenal Hyperplasia), GAL (Galactosemia), PKU (Phenylketonuria), and G6PD Deficiency. In the Philippines, this newborn screening test became a law only in 1996. G6PD deficiency or favism is a deficiency of an enzyme called glucose 6 phosphate dehydrogenase in red cells. When the level of this enzyme is low, the red cells are unable to stand `stressful,' condition, the red cells become damaged and the hemoglobin is denatured. Thus anemia occurs. Bilirubin increases as a waste product of the red cells. This type of anemia that occurs is called `hemolytic anemia". Where in the red cells are destroyed more rapidly than normal (*What is G6PD?* (n.d).

1.2. Methods Used

This research sought to describe the background, blood genetics, diagnosis, symptoms & preventive measures of G6PD Enzyme deficiency. Documentary analysis and actual observation of a G6PD positive child was used as method of this study.

2. Context

2.1. Historical Background of G6PD/Favism

The fava bean (***Vicia faba*** Linnaeus) is thought native to the eastern Mediterranean. The oldest known seeds, probably gathered from wild plants, were found in an archaeological dig near Nazareth and date from 6500 BCE. During the third millennium BCE, the cultivation of fava beans spread over the Middle East, North Africa, and central and southern Europe**.** The consumption of fava beans causes favism (hemolytic anemia) in certain individuals of Mediterranean or African descent. (Vandaveer, 2003**).** Glucose-6-phophate

dehydrogenase (G6PD) deficiency is the most common inborn metabolic disorder in the world. G6PD deficiency is the most common known human enzyme disease, affecting 10% of the world's population. It affects an estimated 400 million people worldwide and is most prevalent in Africa, Southeast Asia and the Middle East. In the Philippines, according to a study conducted on 3,278 male newborns and whose results were published in the journal Pediatric International in February, 2003, the incidence of the disease is 3.9 percent among male Filipinos *(*Gonzales, 2007).

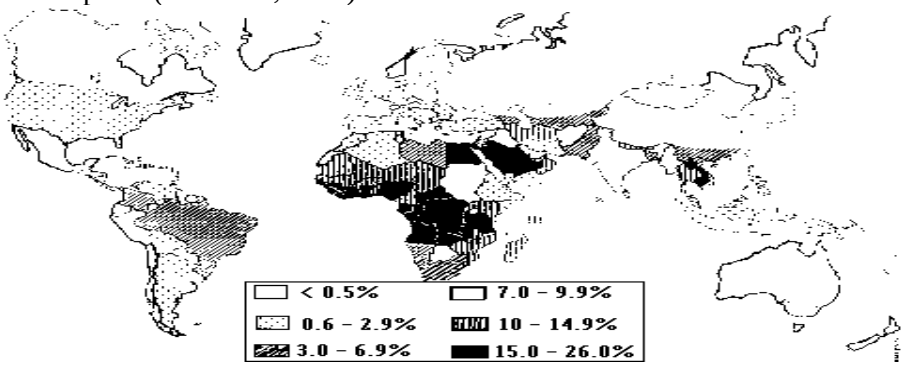

Fig 1: *World distribution of G6PD deficiency* (The values shown by the different shadings are gene frequencies in the different populations*" G6PD-World Distribution*. (n.d))

2.2. Function of G6PD

G6PD is present in the cytoplasm of all cells of the body. In Red Blood Cells (RBC), which lack nuclei, mitochondria, and other organelles, G6PD is particularly significant. It is involved in the first step of the Pentose Phosphate Shunt. Catalyzes the oxidation of Glucose-6-Phosphate to 6-Phosphogluconolactone (Phosphogluconate). It is the only source of NADPH and GSH, necessary for the reduction of hydrogen peroxide. Hydrogen Peroxide is a strong oxidant that will degrade the RBC and cause hemolysis if it is not reduced. (Braunwald et. al, 2001).

2.3. Blood Genetics of G6PD Deficiency

In humans, there are 23 pairs of chromosomes which direct various physical and metabolic traits. One of the 23 pairs of chromosomes is the X and Y- chromosome pair (also known as the sex chromosomes) which determine what sex an individual will be, among other things. The X-chromosome is especially important because it carries genes that are critical to human survival.

Any gene located on the X-chromosome is called an X-linked gene. All X-linked genetic conditions, such as G6PD deficiency, are more likely to affect males than females. G6PD deficiency will only manifest itself in females when there are two defective copies of the gene in the genome. As long as there is one good copy of the G6PD gene in a female, a normal enzyme will be produced and this normal enzyme can then take over the function that the defective enzyme lacks. When a certain heritable trait is expressed in such a manner, it is a called a recessive trait. In males, however, where there is only one X-chromosome, one defective G6PD gene is sufficient to cause G6PD deficiency (Braunwald., 2001**).**

2.4. How is G6PD Deficiency Diagnosed

G6PD deficiency can be diagnosed by a simple blood test. If the ancestors come from an area where G6PD deficiency is common, or if a family has history of G6PD deficiency or unknown anemia, physician should be consulted about having this blood test. Patients with G6PD deficiency and hemolytic anemia can develop jaundice (yellowing of the eyes). Sometimes jaundice can occur in newborn babies who are G6PD deficient.

In the Philippines, Republic Act 9288 - Newborn Screening Act the Newborn screening test was promulgated and became a law in 1996 *(*Padilla, C. 2003).This was done to avoid mortality among infants and to implement preventive and curative measures against metabolic disorders. This test is done by puncturing infants' foot a day after birth. In the Philippines, the sample blood will then sent to the University of the Philippines National Institute of Health for laboratory examination. Infants who were found to be positive are requested to undergo retest to confirm the result.

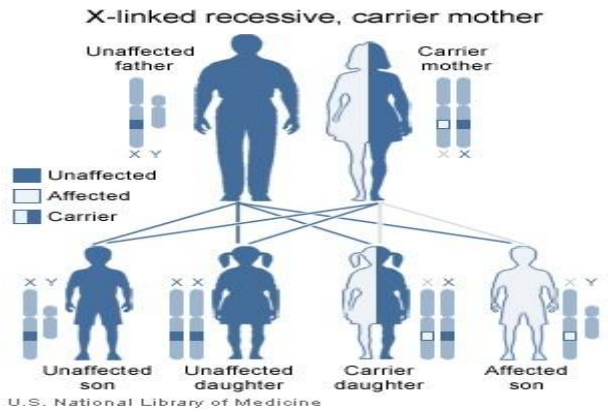

Fig. 2: X-linked recessive=mother to son transmission

2.5. What are the Symptoms of G6PD Attack/Hemolytic Anemia?

Symptoms may include: abnormal paleness, jaundice, or yellowing of the skin, eyes, and mouth, dark colour urine, fever, weakness, dizziness, confusion, and intolerance to physical activity, enlargement of the spleen and liver, increased heart rate (tachycardia), heart murmur (*Genetic Disorders of the Blood*. (n.d)).

2.6. Prevention

Vandaveer A, (2003) reported that "*the most important measure is prevention - avoidance of the drugs and foods that cause hemolysis. Vaccination against some common pathogens (e.g. hepatitis A and hepatitis B) may prevent infection-induced attacks".*

Table 1: Highly oxidative Drugs/chemicals and Foods (Baker, D. 2010)

Generic	Brand Name
A. Antibacterial Nalidixic acid	
Nitrofuran 1. nitrofuracin 2. furazolidone 3. Nitrofurazone/nitrofural	 Macrodantin, Diafuran, Diapectolin, Furoxone Furacin
P-aminosalicsalic acid	
B. Analgesic/Antipyretic Acetanilid	
C. Anthemintic B-napthol Niridazole Stibophan	
D. Sulfonamides & Sulphones Dapsone Glucosulphone sodium Glyburide/Glibenclamide Mafenide acetate Salicyazosuphapyridine/ sulfasalazine Sulphadimidine Sulphafurazone Sulphamethazole	 Lepravir Euglucon, Gluban, Lodulce, Orabetic Bacidal, Bactile Forte, Bactrim, Bacxal, DLI Cotrimaxole, Forteprim, Globaxol, Pharex Cotrimaxazole, Ritemed Cotrimaxazole, Septrin, Trim S
Sulphanilamide	
Sulphapyridine	
Sulphoxone/Sulfoxone	
E. Antimalarials Chloroquine Pamaquine Primaquine	 Aralen, Chlorofoz
F. Miscelaneous Acetylphenylhydrazine	

Dimercaprol Futamide Isobutyl nitrate Mepacrine Phenazopyridine Probenecid Thiazolesulfone Urate oxidase/Rasburicase	Azomir

Chemicals to be avoided by G6PD Positive Individuals

1. Methylene bue 2. Arsine 3. Phenylhydrazine
4. Toluidine blue 5. Trinitrolouene 6. Aniline dyes

Food/Drinks to be avoided by G6PD Positive Individuals

Fava Beans	Dingdong nuts, Mr. Bean
Red wine	
Legumes	Abitsuela, Garbansos, Kadyos, Munggo
Blueberry	
Soya foods	Taho, Tokwa, Soy sauce
Tonic water	
Bittermelon/ amplaya	

Others

menthol	Alaxan gel, Ben-gay, Efficascent oil, Listerine mouthwash, Listerine Pocketpacks, Megascent oil, Mentopas Medicated Plaster, omega painkiller
Camphor	
Naphthalene	Moth balls
Henna	
Herbs	Catlle gallstone bezoar, honeysuckle flower, Chimonanathus flower, 100% pearl powder, Figwortflower, Acalypha indica

Drugs Safe to Take In Therapeutic Doses

Acetaminophen	Paracetamol, Tylenol
Acetophenetidin/phenacin	
Aspirin/Acetylsalicylic acid	Alka-seltzer, aspilets, Cor-80, Cortal
Ascorbic acid	
Chloramphenicol	Chlormycetin, Chloro-S, Chloresig, Klorfen, Oliphenicol, Optmycin, Pediachlor, Penachlor, Speradex
Ciprofloxacin	Ciprobax, Cipromax, Cipromet, Qinosyn-500, Xipro
Diphenyhydramine	
Isoniazid	
Phenytoin	
Qinidine	
Vitamin K analogues/Phytomenadione	Hema-K, Konakion MM/Konakoin MM Phil Phamawealth/Atlantic Phymenadfione

2.7. Treatment

Rosse & Bunn, 1998 as cited by Baker in 2010 stated that "*treatment is applied only when symptoms arise and these can include blood transfusions, maintaining adequate urine output and splenectomy"*. If the anemia is severe, a blood transfusion may be required. In the newborn, a measure to reduce the bilirubin is needed as this is harmful to the baby. This can be done by shining a `blue' light to the baby to destroy the bilirubin through the skin. This is called `phototherapy'. If the level is higher, then an exchange transfusion in which the blood with high bilirubin and low hemoglobin is removed and replaced by blood with low bilirubin and high hemoglobin thus reducing the bilirubin and normalizing the hemoglobin. The patient who suffered a hemolytic episode needs to take plenty of water. Folic acid which helps to increase the hemoglobin and red cells is given (What is G6PD. (n.d).

3. Conclusion

Having a child with G6PD deficiency is inevitable for individuals who inherit this deficiency from their ancestors. A child with this type of metabolic deficiency is physically, mentally healthy. Problem of hemolysis will only come, if he will be subjected to forbidden foods, drugs and chemicals. This metabolic deficiency is not fatal unless a child will be exposed to forbidden drugs, foods and chemicals. Once the

parents know that their sons or daughters are positive for G6PD deficiency, they should do the following; Acceptance and understand in-depth that children with this metabolic deficiency should be taken care of well. Extra care and rear their child not to have exposure on the oxidative food, drugs and chemicals. Inform the child's pediatrician to avoid prescribing sulfa drugs. Have the child undergo complete immunization program against common diseases. Inform hospital personnel about the child's condition in case the child is hospitalized. Post the List of Foods, drugs and chemicals in strategic places in their home. Educate the child's nanny and other family members not to give the child any forbidden foods, drugs and avoid exposure to forbidden chemicals. As the child's grow inform him/her of his/her condition. When the child is in school age, inform the teacher/classmates and cafeteria personnel about his/her condition. It is recommended to raise the child in non-malaria infested areas, since malarial drugs contain highly oxidative ingredients.

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