

Prevalence of Glucose-6-Phosphate Dehydrogenase Deficient Neonates and Cost Effective of Enzyme Screening in Tehran, Iran

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Abstract

Background: Newborn screening is an area with potential for immense impact in lifelong morbidity and mortality. **Objective:** To determine cost effective for glucose-6-phosphate dehydrogenase (G-6-PD) enzyme screening and prevalence of deficiency in newborns and children in Tehran, Iran. **Materials and Methods:** All full term newborns, neonates with icterus and children with acute hemolysis were evaluated to determine prevalence of G-6-PD enzyme deficiency and cost effectiveness of a screening test for G-6-PD enzyme deficiency. The qualitative color reduction test performed on healthy newborns and quantitative test on newborns with icterus and children with acute hemolysis. **Results:** Three (2%) of 146 screened newborns were G-6-PD deficient at a cost of \$ 18 for three positive screening tests and \$ 856 for 143 unaffected newborns Thirty-one (11.4%) of 272 newborns readmitted with icterus were G-6-PD deficient with a cost of 31 tests were \$186 and \$1446 for unaffected newborns. The only significant difference between G-6-PD deficient and normal newborns was bilirubin level ($p < 0.001$). Eleven (0.2%) of 5054 hospitalized children were found to be G-6-PD deficient at a screening cost of \$ 66 and \$ 3.258 for remainder children. The prevalence of G-6-PD is estimated to be approximately 2.4% and 2.2% in males and females respectively. **Conclusion:** Glucose-6-phosphate dehydrogenase screening in newborns is not cost effective and for prevention of hemolysis during the next years all newborns admitted with icterus should be evaluated for G-6-PD enzyme deficiency.

Keywords: Screening, Newborns, G-6-PD

1. Introduction

Mass newborn screening is the second type of prospective care. It is a very important issue for all physicians caring for neonates because it combines a number of significant medical and legal issues. One of the medical requirements of an acceptable mass screening program for a specific disease is that the test should be simple and inexpensive [1]. One of the accepted but less widely practiced screening test is for G-6-PD enzyme deficiency recommended by WHO expert group [2]. In addition, recommendation of WHO is all newborns should be carried out screening in area with a prevalence of G 6 PD deficiency of 3-5% or more in males.[3] In the United States, there are significant state-to-state differences in the disorders that are included in initial newborn screen-

ing, the methods of screening, and follow up [4].

Distribution of the G-6-PD deficiency varies among different population reflecting geographic and ethnic variations. Each society is unique and must make its own choices in neonatal screening based on its economy, epidemiology and ethnics. We have decided to determine prevalence of G-6-PD enzyme deficiency and whether or not G-6-PD screening in newborns is economically effective.

2. Materials and Methods

This prospective study was conducted in Tehran, Iran, at Aria Hospital and Tehran Children Hospital, including neonates born in Aria Hospital from April 2006 through March 2007. After obtaining the informed consent from

one parent enrolled neonates were screened for G-6-PD enzyme level. Similarly enrolled newborns with icterus and hospitalized children with acute hemolysis were screened.

The qualitative color reduction G-6-PD screening test (Kit Saba Laboratory (Tehran, Iran)) was performed on all healthy newborns before hospital discharge. Results were reported as normal or deficient. The quantitative test (kit chem. Enzyme) was performed on children with acute hemolysis and newborns with icterus with results reported in IU/gHb (normal range 7.5-14.5 IU/gHb). We economically compared morbidity (rate of readmission of newborns with jaundice) and children with symptoms of pallor, dark urine, icterus, abdominal pain (acute hemolysis) with G-6-PD screening test results of newborns.

3. Results

During the entire study period, a total of 146 (33.8%) of 431 uncomplicated full term or near term newborns (82 males) with a mean birth weight of 3278.4 g born at Aria hospital were screened for G-6-PD enzyme. Of these, 3(2%) that all were male newborn were G-6-PD deficient at a rate of 20 per 1000 live newborns. The cost of G-6-PD for every one newborn is about \$6 or \$6000 per 1000 newborns. A total of 5054 children with different chief complaints and ages were hospitalized at Tehran Children Hospital over the period, of these, 11(0.2%) or 2 per 1000 hospitalized children with icterus, pallor, dark urine and abdominal pain (acute hemolysis) had consumed fava beans within two days. Of these, 7(63.6%) of 11 children were males. The mean first blood hemoglobin level was 7.8g% and G-6-PD test revealed deficiency. Eight (72.7%) of 11 children were transfused and remainder received supportive therapy and all were discharged after two nights. The cost of two nights hospitalization for one patient with parent is about \$140 or \$1540 for 11 patients. Screening of 5054 patients cost \$30324. The cost of hospitalization of 2 per 1000 children with G-6-PD deficiency is \$280 and the cost of screening 1000 children is \$6000. The comparison of cost of 1000 G-6-PD screening with two deficient per 1000 children is very expensive and is not economical. On the other hand, 31(11.4%) of 272 icteric newborns (13 males) who were admitted over the same period were G-6-PD deficient and 6 (19.3%) of 31 newborns (3 females) received exchange transfusion. The prevalence of G-6-PD deficiency is approximately 2.4% and 2.2% in male and female newborns respectively and characteristics of newborns are shown in **Table 1**. The only significant difference between normal and deficient G-6-PD newborns is bilirubin level ($p < 0.001$). There is no statistically significant difference between exchange trans-

Table 1. Characteristics and laboratory examination of newborns with jaundice.

	Normal G-6-PD		G-6-PD deficient	
	Normal G-6-PD	Exchange transfused	G-6-PD deficient	Exchange transfused
Total No	236	13	31	6
Males	121	6	18	3
Females	115	7	13	3
Age / day	8.6	5.7	6.4	4.9
Hemoglobin g%	14	15.9	15.4	17.4
Reticulocytes%	0.9	1.7	1.2	1.2
Bilirubin mg%	15.9	27	21.6	28.4

The numbers are defined as mean

fused newborns with normal G-6-PD and deficient newborns.

4. Discussion

In the current study we showed cost of G-6-PD screening in uncomplicated healthy full term newborns. In icteric neonates associated with G-6-PD deficiency their jaundice can not be related only to G-6-PD deficiency but confounding factors such as breast milk, or poor nursing technique and perinatal factors such as maternal diabetes, induced or augmented labor, superimposed on G-6-PD deficiency may exacerbate hyperbilirubinemia, treatment costs, duration of hospitalization and need for exchange transfusion.

Clearly, the fact that a G-6-PD deficient infant also develops hyperbilirubinemia or kernicterus does not mean that G-6-PD deficiency was the primary cause of the severe hyperbilirubinemia [5]. In our study such confounders can-not be defined and we can not attribute all hyperbilirubinemia to G-6-PD deficiency. In our study, G-6-PD deficiency in newborns or children does not induce morbidity or mortality such as mental retardation or other irreversible clinical manifestation. The most common clinical manifestations of G-6-PD deficiency is neonatal jaundice and acute hemolytic anemia in children related to medications such as Chinese remedies, naphthalene, henna, fava and oxidant drugs particularly in Iran, henna, fava bean, naphthalene, aspirin and infection. The only clinical manifestation in our newborns with G-6-PD deficiency was bilirubin level higher than normal G-6-PD newborns **Table 1**. Routine screening of all newborns will not identify every affected G-6-PD deficient newborns. The male G-6-PD deficient infants will be detected, but many heterozygote females will be missed [6]. In our study, all newborns screened for

G-6-PD deficiency were males. There were not differences between hemoglobin level and number of reticulocytes on automated differential in G-6-PD deficient and normal G-6-PD newborns. We do not have evidence of hemolysis in newborns. Although it has previously been shown that G-6-PD deficiency can induce kernicterus as a complication of G-6-PD deficiency associated neonatal jaundice in many population groups [7] our study did not demonstrate any kernicterus in newborns with jaundice. Our study demonstrated prevalence of G-6-PD deficiency approximately 2.4% in males and it is versus of recommendation of WHO [3]. Given that in this study only 0.2% of young children were admitted with acute hemolysis from fava bean ingestion. If we compare them with children due to gastroenteritis with prevalence of approximately 41% is extremely low [8]. In comparison the cost of newborn screening is also low. Currently, to our knowledge, newborn G-6-PD screening is not performed in the other provinces of Iran and the prevalence of G-6-PD deficiency in north, south, east and west provinces should be different and I hope to be determined by other investigators.

5. Conclusions

This study demonstrated that global G-6-PD enzyme screening in newborns in Tehran, Iran for prevention of hemolysis following ingestion some drugs, fava beans or simultaneous with infection during the next years is not economically feasible. We suggest all newborns with jaundice should be evaluated for G-6-PD enzyme deficiency and that prevalence of deficiency in all provinces of Iran should be determined before establishing a universal Iranian G-6-PD deficiency screening program.

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7. References

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