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Original Article

High Blood Mercury Levels in Iranian Infants: A Cause for Concern

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ABSTRACT

Background and Objective: **There have been concerns over possible association between mercury and neurodevelopmental outcomes in infants. In this study we aimed to determine whether blood levels of mercury are above safe values in Iranian infants or not.**

Materials and Methods: **A total of 85 infants (0, 2, 4 and 6 months old) were enrolled in this study. All of them received vaccines according to Iranian immunization schedules. We measured total mercury in all blood samples by cold vapor atomic absorption.**

Results: **The mean concentration of blood mercury in our subjects were as follows: newborns as 33.95 ± 11.86 nmol/l (with a range of 23.93-52.84), 2 months as 32.94 ± 11.76 nmol/l (with a range of 23.92-52.84), 4 months as 30.44 ± 10.44 nmol/l (with a range of 23.92-50.85) and 6 months as 37.93 ± 12.97 nmol/l (with a range of 21.43-52.34). There was not any significant difference for the mean concentration of blood mercury in those age groups. The lowest level of blood mercury detected was 21.43 nmol/l and the highest level was 52.84 nmol/l.**

Conclusion: **The finding of this study showed that approximately 33% of the infants had blood mercury levels above the U.S. Environmental Protection Agency recommended reference dose of 5.8 µg/l (29 nmol/l). Therefore, it is needed to reduce exposure of infants to mercury from all sources including thimerosal containing vaccines (TCVs) in Iran.**

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Introduction

In an uncontaminated environment, the general population is exposed to mercury from the atmosphere and from dental amalgams (1;2), while the diet and mainly fish is the principal source for mercury absorption (3). Mercury occurs in three forms: the metallic element, inorganic salts, and organic compounds (e.g., methylmercury, ethylmercury, and phenylmercury) (4). Thimerosal (sodium ethylmercury -thiosalicylate) is a preservative containing 49% ethyl mercury by weight which has been in use, in concentrations ranging from 0.003 to 0.01% (30-100 μg/ml) since the 1930s (1;5). Thimerosal was used to prevent bacterial and fungal contamination. Depending on the immunization schedule, vaccine formulation, and infant weight, cumulative exposure of infants to mercury from thimerosal during the first 6 months of life may exceed Environmental Protection Agency (EPA) guideline level of 5.8 μg/l (29 nmol/l) (5).

Most of the toxic effects of organic mercury compounds take place in the central nervous system, although the kidneys and immune system can be affected as well (6).

Findings about the effect of mercury exposure on neurodevelopment in infants are controversial (7;8). Studies from the Faroe Islands reported that subtle cognitive deficits (e.g., performance on attention, language, and memory test) were associated with mercury levels previously thought to be safe (7). Studies in Seychelles did not reveal any correlation between abnormalities and mercury levels (8).

High blood mercury levels especially in the first 6 months of age remain a public health issue. Therefore, the purpose of this study was to measure concentrations of mercury in blood of Iranian infants.

Materials and Methods

A cross-sectional study was carried out to assess blood concentration of mercury (Hg) in Iranian infants. Four groups of infants at birth (0), 2 months, 4 month and 6 months were studied .All the infants were recruited during routine well-child examination and vaccination visits by the investigators between May and July 2006. All children remained healthy throughout the study. Written informed consent was obtained from parents for all procedures.

The number of infants in this study was 25 (19 males and 6 females) newborns (0-1 month), 25 infants aged 2 months (13 males and 12 females), 15 infants aged 4 months (13 males and 2 females) and 20 infants aged 6 months (11 males and 9 females). Mean weight of infants at sampling time and their birth weight were as follows respectively: newborns as 3.54 ± 0.74 kg and 3.15 ± 0.61 kg, 2 months as 4.71 ± 1.01 kg and 3.06 ± 0.54 kg, 4 months as 7.12 ± 0.82 kg and 3.47 ± 0.68 kg, 6 months old as 7.59 ± 1.1 kg and 3.13 ± 0.70 kg.

Vaccines containing thimerosal that were given to infants according to Iranian immunization schedules included diphtheria-tetanus-pertussis adsorbed vaccine (Razi Institute, Iran; 0.01% thimerosal, 25 μg mercury per dose) and Hepavax-Gene (hepatitis B vaccine; Berna, Korea; 0.01% thimerosal, 12.5 μg mercury per dose).

All of the infants were exposed to 12.5 micrograms (μg) of mercury at birth from hepatitis B vaccine (HBV vaccine), 37.5 μg of mercury at 2 months from diphtheria-tetanus-pertussis (DTP) and HBV vaccines, 25 μg of mercury at 4 months (DTP vaccine), 37.5 μg of mercury at 6 months (HBV and DTP vaccines), for a total of 112.5 μg of mercury according to Iranian immunization schedules. We obtained 2.5 ml of whole blood during a visit 2–28 days after vaccination. Blood samples were treated with EDTA and kept at 4 °C. Total mercury was measured in all samples by cold vapor atomic absorption (400 A, BUCK Scientific Inc., UK) as previously described (9). The limit of reliable measurement in this assay was 4.98 nmol/l. Parameters for the measurement are as follows: recovery was equal to 90% (external standard was used); limit of detection was 0.05 parts per billion. Calibration curve was in the range of 0.1 to 100 parts per billion.

Statistical analysis

Chi-square and t tests were used (SPSS 11.5) for statistical analysis. Data are presented as means ± standard deviations or, when indicated, as absolute number and percentage. A p value less than 0.05 was considered significant.

Results

A total of 85 infants (80 term and 5 preterm ones) were enrolled in this study. The mean concentration of blood mercury in our cases were as follows: newborns as 33.95 ± 11.86 nmol/l (with a range of 23.93-52.84), 2 months as 32.94 ± 11.76 nmol/l (with a range of 23.92-52.84), 4 months as 30.44 ± 10.44 nmol/l (with a range of 23.92-50.85) and 6 months as

37.93 ± 12.97 nmol/l (with a range of 21.43-52.34). The mean concentration of blood mercury in all subjects was 33.97 ± 11.93 nmol/l (with a range of 21.43-52.84 nmol/l). There was not any significant difference regarding mean concentration of blood mercury in those age groups (ANOVA). Mercury concentrations were not below the range of reliable quantitation in any samples.

The lowest level of blood mercury detected in this study was 21.43 nmol/l which was measured 26 days after vaccination in a 6-month-old male infant weighing 6.7 kg, with a birth weight of 2.95 kg, who had received DTP and HBV vaccines containing a total dose of 37.5 µg mercury. The highest level of blood mercury was 52.84 nmol/l, which was measured 14 days after vaccination in a 2-month-old male infant (75 days) weighing 5.3 kg, with a birth weight 3.6 kg, who had received HBV and DTP vaccines containing a total dose of 37.5 µg mercury and a female newborn 4-days-old weighing 3.55 kg, with a birth weight of 3.40 kg, who had received HBV vaccine containing a total dose of 12.5 µg. Distribution of infants according to mean blood mercury in various ages and time of sampling (days since last vaccine) is shown in Table 1. Distribution of Hg levels and days since last vaccine according to age groups is showed by Pearson coefficient in Figures 1-4. There was not any significant difference regarding mean concentration of blood mercury in those age groups at various time points after exposure ($p>0.05$).

Table1: Distribution of infants according to mean mercury level and time of sampling (days since last vaccine)

Mean mercury levels in different age groups	Time point			
	≤7 days	8-14 days	15-21 days	22-28 days
Newborn infants	40.1 ± 18	36.4 ± 13.9	30.7 ± 9.6	34.5 ± 12.9
2 months-old infants	28.6 ± 9.2	29.8 ± 10.2	39.8 ± 14.5	36.5 ± 13.5
4 months-old infants	29.8 ±11.5	24.4	38.4 ± 14.1	25.9 ±1.3
6 months-old infants	37.4 ± 13.3	36.4 ± 13.7	42.4 ± 13.9	37.9 ± 16.7
Total	16	20	20	27

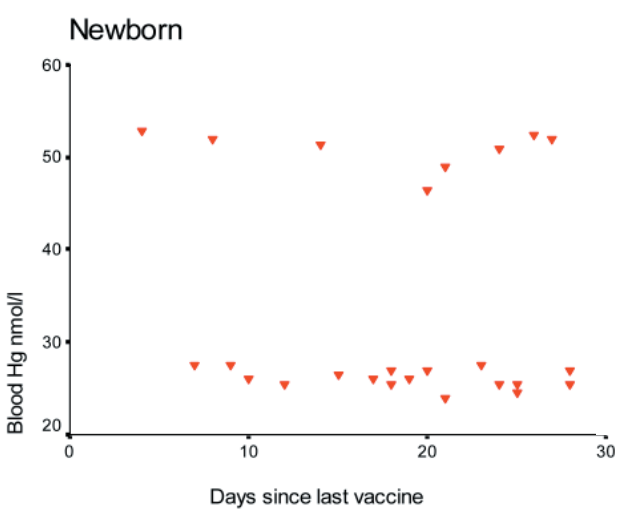

Fig. 1: Distribution of Hg levels and days since last vaccine in newborn infants (Pearson coefficient = 0.09)

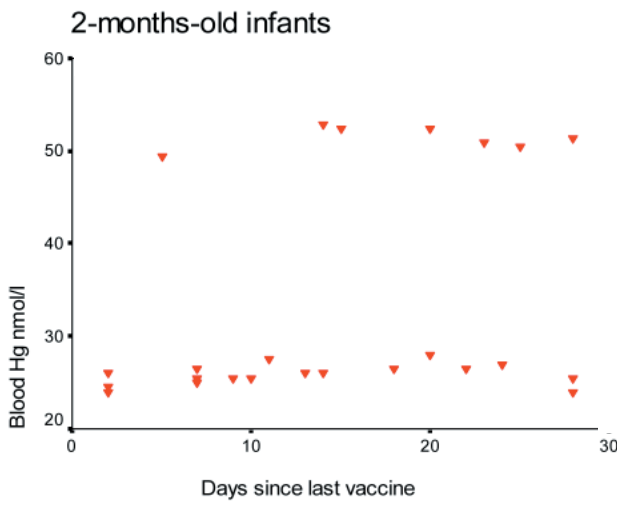

Fig. 2: Distribution of Hg levels and days since last vaccine in 2-months-old infants (Pearson coefficient = 0.31)

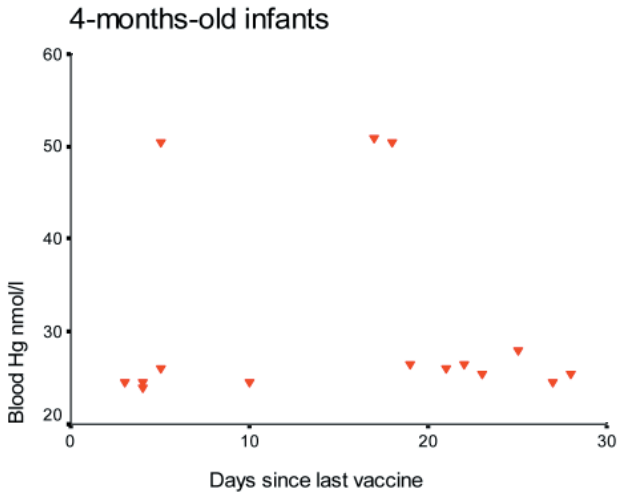

Fig. 3: Distribution of Hg levels and days since last vaccine in 4-months-old infants (Pearson coefficient = 0.07)

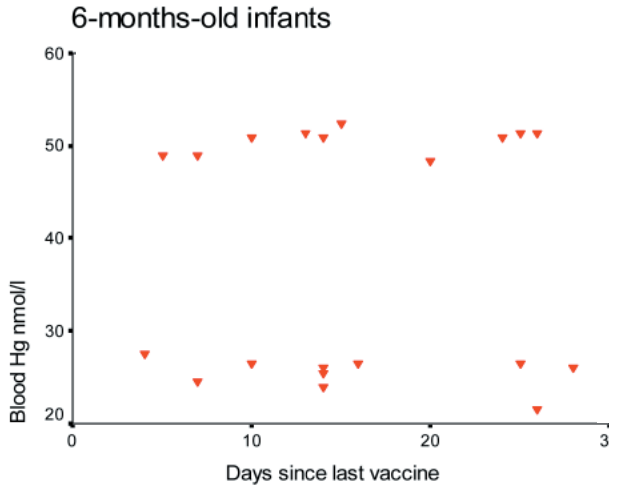

Fig. 4: Distribution of Hg levels and days since last vaccine in 6-months-old infants (Pearson coefficient = 0.002)

A total of 32.9% children had a blood mercury concentration exceeding 29 nmol/l, which is the concentration thought to be safe in the cord blood. There is no significant difference between 2 groups of infants with safe blood mercury levels (<29 nmol/l) and unsafe levels (≥29 nmol/l) regarding age, gender, weight and birth weight (ANOVA). Out of 85 infants enrolled in this study, 5 were preterm and the others were term. Only one of them had a mercury concentration above safe value (29 nmol/l). He was a 6 months-old infant weighing 9.90 kg, with a birth weight of 1.50 kg and a mercury level of 52.34 nmol/l, who had received HBV and DTP vaccines containing a total dose of 37.5 µg. Mercury was measured 15 days after vaccination.

Discussion

The results of this study showed that 32.9% of the studied infants (aged 0–6 months) had a concentration of blood mercury exceeding 29 nmol/l; the concentration is thought to be safe in cord blood (10). This value was set at ten times below the lower 95% CI limit of the minimal cord blood concentration associated with an increase in the prevalence of abnormal scores on cognitive function tests in children (11).

There are limited studies regarding blood mercury levels in infants. Pichichero et al (4) investigated the concentration of mercury (Hg) in blood, urine, and stools of 61 infants aged 2 and 6 months. Forty of the sixty-one infants were given vaccines that contained thimerosal and 21 received thimerosal-free vaccines. The study results indicated low Hg levels in the blood of the infants, ranging from 3.7 to 20.5 nmol/l in 2-month-old infants and less than 7.5 nmol/L in all 6-month-old infants. No child had a concentration of blood mercury exceeding 29 nmol/l. Stajich et al (12) found that following a dose of thimerosal-containing hepatitis B vaccine, prevaccination blood Hg levels increased from 0.54 to 7.36 µg/L in 15 preterm infants, and from 0.04 to 2.24 µg/l in 5 term infants.

Using national blood mercury prevalence data from the US Center for Disease Control and Prevention, Trasande et al (13) found that between 316,588 and 637,233 children each year have cord blood mercury levels above 5.8 µg/l, a level associated with loss of IQ. The resulting loss of intelligence can cause diminished economic productivity that persists over the entire lifetime of such cases. Results of one study suggested that cord and maternal blood mercury levels are associated with delayed psychomotor development of infants in the first year of life (14). Organic mercury readily crosses the blood-brain barrier and infants are more sensitive to mercury exposure than children or adults (4).

In this study, blood samples were obtained at various time points after exposure. Assessment of these samples suggested that some infants may receive cumulative exposure to mercury, which may be of concern and exceeds EPA agency recommendation for mercury exposure. It is very likely that some of the mercury detected in the infants' blood in this study is derived from exposures other than TCVs. But we should consider that thimerosal-containing vaccines

are one of the sources of blood mercury in our subjects. In addition, the results of our study showed that mercury levels in the blood of Iranian infants were above concentrations potentially associated with toxic effects. There is a need to minimize exposure to mercury from all sources such as food (especially certain fishes), pharmaceuticals, and biological products. In Iran, TCVs are administered to all infants including very low birth weight premature infants and also term infants, regarding to our results it seems that thimerosal in TCVs poses risk to them. Several approaches are available to reduce exposure of children to thimerosal. Clinicians may select existing products not containing thimerosal. Reformulation of vaccines in single-dose vials may eliminate the need for a preservative.

Conclusion

The results of this study require additional confirmation in further studies on the pharmacology and pharmacokinetics of thimerosal in infants.

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