Leaded Eye Cosmetics: A Cultural Cause of Elevated Lead Levels in Children

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Background. Preventing lead exposure is of paramount importance because lead is significantly toxic at subclinical levels, and treating patients with elevated blood lead levels is difficult. Children were evaluated for lead exposure in California through a state-mandated lead screening program that was begun in November 1991. Imported eye cosmetics were identified as a suspected source of lead exposure for Pakistani and Indian children who used these products.

Methods. A retrospective chart review of children at a county hospital clinic was undertaken for the period beginning October 1991 and ending February 1994. Lead exposure questionnaires were filled out at clinic visits, and telephone interviews were conducted with parents or guardians of children from ethnic groups who use eye cosmetics.

Results. Lead level results were available for 175 children. The average lead level was 4.3 μg/dL (0.21 μmol/L) for Pakistani/Indian children not using eye cosmetics and 12.9 μg/dL (0.62 μmol/L) (P=.03) for those using the products. Chemical evaluation of some of the eye cosmetics used by these children revealed high lead content.

Conclusions. Use of eye cosmetics imported from Pakistan was found to be strongly correlated with elevated blood lead levels. Although importation of leaded eye cosmetics is prohibited by law, legislation has not been effective in protecting children from this source of lead exposure. Education regarding low-level lead toxicity and avoidance of substances containing lead is needed, particularly for targeted subpopulations.

Key words. Lead; environmental exposure; lead poisoning; surma, kohl; cosmetics(eye); child welfare.
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Lead is becoming recognized as the major environmental toxin for children in the United States.[1] Although environmental sources of lead exposure have been reduced, lead toxicity remains a hazard for children. With the recent finding that even low-level lead exposure has toxic effects on the central nervous system in children,[2–7] it has become even more important to remove or reduce previously ignored or unrecognized sources of lead exposure (Table 1). One source is eye cosmetics containing lead. Surma, kohl, and alkohl are names for eye cosmetics often used by persons from the Indian subcontinent and the Middle East. These preparations of powders, gels, or water-based fluids are illegally imported into the West and are used on children and adults. Although ancient reports indicate that antimony was used to make these cosmetics, many modern preparations contain high levels of lead.

Neurotoxicity at low levels of lead exposure was not clearly demonstrated until the last 20 years. Formerly "safe" levels are now known to cause significant problems with overall intellectual function and academic achievement and adjustment in children. The blood lead level threshold for adverse effects has been progressively lowered from about 150 μg/dL (7.24 μmol/L) in the 1930s, to 80 μg/dL (3.86 μmol/L) in the 1970s, and down to 10 μg/dL (0.48 μmol/L) (for children) in 1991.[8,9] Studies in China, Australia, and the United States[6,7,10] have revealed a correlation between lower intelligence testing scores and low-level lead exposure. An

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Table 1. Folk Medicines and Cosmetics That Are Potential Sources of Lead Exposure

Mexican products
Azarcon: Bright orange powder-mix of red lead oxide and white lead carbonate; also known as Rueda, Coral, Maria Luisa, Alarcon, Liga (80% lead content)
Greta: Yellow, slightly green powder or lead tetraoxide (80% lead content)
Asiatic Indian products
Ghasard: Brown powder given to aid digestion
Bala Goli: Round, flat, black "bean" dissolved in "gripe water" and used for stomachache
Kandu: Red powder used to treat stomachache
Surma: Black powder, gel, liquid used as eye cosmetic (16% to 80% lead sulfide)
Hmong product
Pay-Loo-Ah: Red powder given for rash or fever
Asiatic Indian and Arabic products
Kohl (Alkohl/Ceruse): Powder used as cosmetic eye makup and applied on skin infections and on the navel of a newborn (16% to 80% lead sulfide)
Kajal (Kajjal, Kaajal, Kajjali): Sticky, solid eye cosmetrics prepared from carbon soot; usually lead-free

increase in IQ scores has been shown for children following chelation therapy for lead poisoning.[11]

Reviews of international studies[2–4,8] have shown an inverse relation between blood lead levels (10 μg/dL [0.48 μmol/L] and above) and IQ as measured by standard tests. The average decline of IQ scores among subjects in these studies has been 4 to 7 points for each 10 μg/dL (0.48 μmol/L) increment in blood lead level. In addition, in a review of many of the studies to date, Goyer[8] noted a nearly fourfold increase in the number of children with severe deficit (IQ score below 80) and a 5% reduction in the number with an IQ score over 125 among the group of children with high blood lead levels (more than 10 to 15 μg/dL [0.48 to 0.72 μmol/L]).

The threshold below which toxic effects of lead do not occur is uncertain, but even the lowest levels of lead exposure have been demonstrated to affect the fetus. Lead is passed transplacentally, with maternal and cord blood levels being nearly identical.[12] Research on central nervous system (CNS) toxicity has shown more severe effects from lead exposure in fetal pups than in those over 20 days of age, probably because of the tempering effect of a CNS protein that is present in higher levels in more mature animals.[13] A similar increase in protein has been shown in rats.[14]

Although the exact mechanism of lead neurotoxicity is not clear, the toxic effects of low levels of lead exposure on the CNS in children is now well documented. Because the effects are subclinical, screening, rather than case finding only, is needed until the population at risk can be more accurately defined.

Methods

Because of the confirmed toxicity of low levels of lead exposure, a lead screening program for children under 6 years of age was begun in California at the end of 1991. This statewide program requires testing for blood lead levels in children aged 1 to 6 years and a review of each child's environment for possible lead sources. The Centers for Disease Control and Prevention also recommends screening of the preschool population.[15] Specific follow-up is recommended by the state for children with blood lead levels above 10 μg/dL (0.48 μmol/L) and rapid reevaluation for children with levels of 25 μg/dL (1.21 μmol/L) or more. Zinc protoporphyrin testing, formerly used for finding persons with lead levels above 25 to 40 μg/dL (1.21 to 1.93 μmol/L), is not a reliable test for low-level lead screening because it does not register blood lead levels of less than 15 μg/dL (0.72 μmol/L).

A retrospective chart review of 1200 children was undertaken in a county hospital clinic for the period beginning October 1991 and ending February 1994. The charts were selected by a computer listing of all the children who received fluoride prescriptions (N=1354). The group was further defined by selecting children aged 8 months to 6 years (n=1200). Blood levels were not available for all the children who were initially selected for chart review because some did not continue visiting the clinic, some were too young for screening, and some had only acute care visits (anything other than well-baby or well-child care). Data on cultural group, age, sex, lead levels, and use of eye cosmetics were gathered. One hundred eighty-nine lead-level results, which represented 175 children, were available.

Beginning in November 1991, a questionnaire provided by the state of California was used to review all children's environments for sources of lead. For infants, the questionnaire was usually completed with the parent(s) at the 6- or 9-month well-baby visit; the lead level was usually measured at the 1-year visit. Children who were between 1 and 6 years old were screened at any visit possible. The Women, Infants, and Children Supplemental Food Program requires routine hematocrit and hemoglobin screening. These visits and those for acute care were often used as opportunities to screen for lead exposure, particularly when the visit required blood drawing.

Table 2. Results of Blood Lead Level Screening of Children Aged 1 to 6 Years in California, 1991–1994

Study Subjects	No. of Children	No. of Children with Blood Lead Levels ≥10 μg/dL	Mean Blood Lead Level, μg/dL
All	175	20	5.7
Non-Pakistani/non-Indian	157	12	5.5
Pakistani/Indian	18	8	9.8
Eye cosmetics use			
Used	11	7	12.9*
Never used	3	0	4.3
Unknown	4	1	5.8

*P=.03.

The standard questionnaire provided by the state did not contain any questions regarding the use of eye cosmetics. A registered nurse who spoke Urdu, the language of Pakistan, conducted a telephone survey of the parents or guardians of children from ethnic groups who use eye cosmetics.

In accordance with the law, the public health department was given a list of children with high lead levels in order to perform environmental tests. The homes of some of the children with elevated lead levels were examined by the environmental health division of the local public health department. The home surveys were not consistently accompanied by complete laboratory testing of samples because of insufficient funding.

Approximately 14% of the 1200 children's charts reviewed contained lead level measurements. Many of these children were seen only once at the study site or were transferred to other clinics for care after a few visits. Approximately 30% of the newborns continued their care elsewhere. Some children were transferred to other clinics because of geographic and insurance considerations. Data collection was undertaken before the beginning of the state screening program; therefore, lead screening was not uniformly ordered by all providers at the clinic during the first part of the study. Finally, many of the older children who were not screened had few visits, often only one. Practices with more stable populations should achieve higher screening rates as they become familiar with a screening program. The California screening program plans a more targeted approach following a review of the initial results of the present comprehensive screening.

Results

Tables 2 and 3 show the results of lead screening for the various groups of children. The only significant factor was the difference between users and nonusers of eye cosmetics. Among the Pakistani and Indian children (the only children's groups with a history of eye cosmetics use), use of the cosmetics varied (Table 3). Most of the families who used eye cosmetics applied them daily from the time of birth. Cosmetics were usually applied to the edge of the lid (upper, lower, or both) along the lashes (Figure), but some applications covered the entire upper lid. Many families instilled eye cosmetic powders and solutions into the eye. Although the children under 2 years of age had a shorter period of exposure than the older children, a higher percentage (not statistically significant in our small sample) of the younger ones had lead levels greater than 10 μg/dL (0.48 μmol/L). Families who used eye cosmetics on their children appeared to apply the cosmetics more regularly to the infants than to the older children.

Table 3. Blood Lead Levels and Frequency of Leaded Eye Cosmetics Use in 18 Pakistani/Indian Children

Case Number	Age at testing, y	Blood Lead Level, μg/dL	Eye Cosmetics Application
1	6	2	Unknown
2	2	3	Unknown
3	2	3	Never
4	2	4	Never
5	Unknown	4	Unknown
6	1	6	Never
7	1	7	1 to 3 times weekly from birth to 3 years
8	3	7	Unknown frequency from birth to 1 year
9	3	8	3 times weekly, from birth to 4 years 9 months
10	5	9	Daily from birth to 5 years
11	1	10	Daily since birth
12	3	10	Daily since birth
13	1	13	Daily from birth to 1 year
14	2	13	Unknown
15	1	15	Daily since birth
16	1	17	Three times weekly from birth to 3 years
17	1	22	Daily from birth to 3 years
18	3 months	24	Daily from birth to 15 months

Families who wanted to use eye cosmetics were advised to use only products made in the United States rather than imported eye cosmetics. Most of the families elected to stop using eye cosmetics on the children.

Questionnaires performed at well-baby and well-child visits did not reveal other sources of lead exposure (eg, industrial and domestic environments, folk medicine, or other significant sources). There were no statistically significant differences in the lead exposure questionnaire results for the different groups of children (white, Hispanic, Pakistani/Indian, other, and users/nonusers of eye cosmetics).

A sample of kohl from the family of our index case revealed 16.4% lead content. Another sample from another child's family (checked by the public health depart-

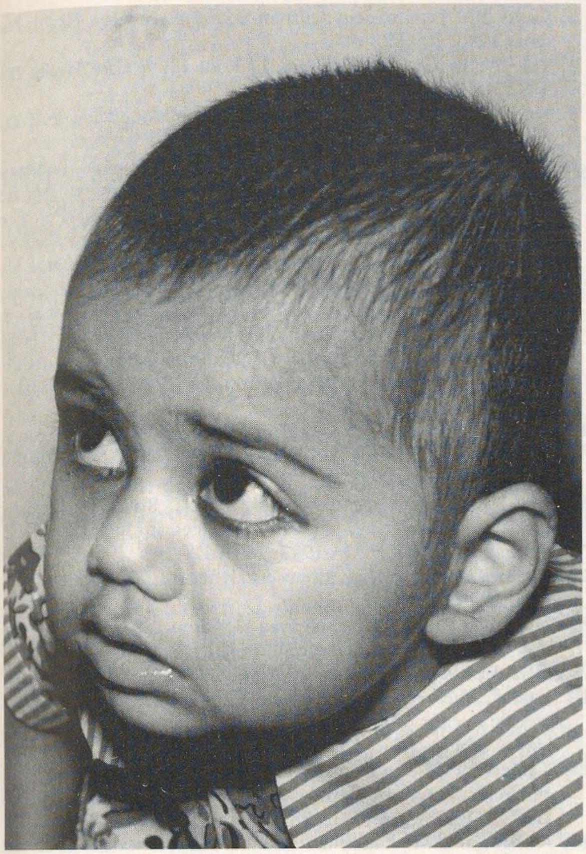

Figure. Typical application of eyeshadow, as shown on this child, includes coverage of the lid edges as well as placement into the eye and along the lateral lids.

ment through another laboratory) revealed a lead level of 70%. Galena, which is 86% to 88% lead sulfide, is a lead ore that is often ground into powder for use in surma or kohl preparations.[16] Most of the families in our clinic who applied eye cosmetics to their children used powder, gel, or liquid mixtures obtained from Pakistan. They reported that some families use mixtures made by relatives and that others obtain the eye cosmetics from commercial sources. The families were also able to point out that several local stores sold similar compounds imported from Pakistan and India.

Discussion

Significant amounts of lead can be absorbed from the use of eye cosmetics containing lead.[16,17,19–24] Cosmetic plumbism has been recognized in Western cultures[19,23] and in the Indian literature.[22] Lead is more likely to be absorbed gastrointestinally by the oral route or by means of nasolacrimal duct intake than to be absorbed transcorneally.[21] Conjunctival absorption is more difficult to quantitate since tears are collected in the nose and swallowed, contributing to gastrointestinal absorption. Surma, kohl, or alkohl, as these eye cosmetics are called, may be ingested by means of rubbing the eyes and then licking the fingers.[16,17,21] The addition of menthol or other irritating agents to many of these eye preparations makes tearing, and therefore eye rubbing, likely consequences of each application.

Gogte et al[17] found that the quantity of surma used per person per day averaged 10 to 15 mg. If 10 to 15 mg of surma containing 16% to 70% lead is used daily, the lead intake (total available for absorption) is 1.6 to 10.5 mg. Since children absorb 30% to 50% of available lead (through the gastrointestinal tract), 0.48 to 5.25 mg of lead could be absorbed daily from the use of lead-containing eye cosmetics. Children develop a positive lead balance at $\geq 5\ \mu g$ ingested lead per kg of body weight per day.[18] For example, in a 1-year-old 10-kg child, the maximum amount of lead that could be ingested without a toxic effect would be 50 μg per day. Children absorb a greater fraction of ingested lead than the 10% typically absorbed by adults. Therefore, children can develop a positive lead balance even at low levels of eye cosmetic use.

Nir et al[20] showed a higher lead level in children whose mothers used kohl, even if kohl was not used on the children, suggesting household and person-to-person contamination. Reports of lead poisoning related to the use of lead-containing eye cosmetics have been published since 1968, but with the evolving definition of permissible lead levels, it is clear that classic poisoning accounts for only a small portion of lead toxicity from kohl and surma use in children. Previous evaluations of imported eye cosmetics showed lead contents ranging from 16% to 90%, although some samples with a charcoal or soot base have virtually no lead content.[16,21]

Our patients' families indicated that they used cosmetics to prevent loss of vision and for cultural reasons. Ancient sources indicate that the use of eye cosmetics to prevent "evil eye" or loss of vision was associated with antimony-containing substances, but a more recent (400 AD) writer advised powdered lead sulfide applications for preserving vision.[17] Antimony has not been found in modern cosmetic formulations.[16]

Conclusions

The use of eye cosmetics imported from Pakistan and India was found to be positively and strongly correlated to elevated blood lead levels on routine screening in this study. The amount of lead absorbed from daily use of these eye cosmetics is well within the range needed to produce the blood lead levels seen in the children in this study. Although a complete examination of the environments of the children was beyond the scope of this study, it is unlikely that sources of lead exposure other than the cosmetics were responsible for the high levels of lead found in the blood of subjects in this study. There was a very high correlation between the use of eye cosmetics containing lead and the high blood lead levels found in the group of children using the cosmetics.

According to the California Department of Finance, Demographics Section, there are 20,683 children in California who are at least 6 years old and are of Asian/Indian subcontinent heritage (Data on file. California Department of Finance, Demographics Section, Sacramento, 1994). Among this study population, approximately one half of the Pakistani children have eye cosmetics applied, but the few Indian children included do not. Many families of other Middle Eastern origins also use lead-based eye cosmetics. A large number of these children may be at risk for subclinical lead toxicity. This constitutes a significant public health problem which can be most effectively addressed through education. Although laws in the United States and Great Britain restrict the entry of leaded cosmetics and medications, importation of these dangerous substances continues. Education is the best means of decreasing the likelihood of lead toxicity in children who are at greatest risk because of cultural practices.

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