Title: The failure of CDC screening questionnaire to efficiently detect elevated lead levels in a rural population of children
Author(s): Louis A. Kazal
Source: ***Journal of Family Practice***. 45.6 (Dec. 1997): p515.
Document Type: Article
Full Text:

BACKGROUND. In 1991, the Centers for Disease Control and Prevention (CDC) lowered the level for lead toxicity from 25 [micro] g/dL to 10 [micro] g/dL and published guidelines recommending that all children be tested for blood lead level at 12 months of age and again, if possible, at 24 months. The guidelines also called for periodic universal screening of children between the ages of 6 and 72 months using the CDC's lead screening questionnaire. However, blindly following these recommendations may result in unnecessary patient discomfort, wasted time, and extra expense. According to the CDC guidelines, deviation from this practice requires the determination of the local prevalence of lead poisoning. The purpose of this study was to measure the local prevalence of elevated blood lead levels (EBLL) and to assess the utility of the CDC's lead screening questionnaire in a rural setting.

METHODS. Three hundred seventy-six children living on the Navajo Reservation in Arizona were studied. A consecutive series evaluation at well-child visits between the ages of 6 and 72 months was conducted using the CDC lead screening questionnaire and blood lead levels measured by anodic voltammetry.

RESULTS. Of 376 children, 368 had their blood levels tested. Eight children tested positively with an EBLL of [is greater than or equal to] 10 [micro] g/dL for a prevalence of 2.2%. Three hundred twenty-three completed questionnaires; 83 (25.7%) of these children had false-positive results. The sensitivity and specificity of the CDC lead screening questionnaire were 42.9% and 73.7%, respectively. The positive predictive value of the questionnaire was 3.5%.

CONCLUSIONS. In this rural population of children, the prevalence of lead poisoning was low, and the CDC lead screening questionnaire failed to efficiently identify those children with lead toxicity. Screening such a population using the CDC guidelines will result in unnecessary discomfort for children and will squander limited resources of time and money. Physicians who care for children should know the local prevalence of EBLL in order to effectively follow the CDC's recommendations for lead screening.

KEY WORDS. Lead poisoning; children; screening; prevalence; questionnaires; Centers for Disease Control and Prevention. (J Fam Pract 1997, 45:515-518)

Lead is a ubiquitous metal that serves no known physiological purpose. Once inside the body, it becomes a poison that can adversely affect any system, including the developing brain and nervous system of a child. In the past decade, increasing evidence has shown that cognitive impairment in children occurs at lower blood lead levels than previously recognized. In a 1991 document, the Centers for Disease Control and Prevention (CDC) lowered the lead toxicity level from 25 [micro] g/dL to 10 [micro] g/dL and recommended that all children be tested for blood lead level at 12 months of age and again, if possible, at 24 months.(2) The CDC guidelines also called for universal screening of all children at each regular visit from 6 to 72 months of age using a 5-item questionnaire. Any yes answer categorizes the child as being at "high risk" for lead poisoning and mandates a blood lead level measurement. Additionally, it is suggested that children with a positive questionnaire be retested every 6 months, even if their blood lead level is [is less than] 10 [micro] g/dL. Following the return of two normal blood lead level tests ([is less than]10 [micro] g/dL), the recommended testing frequency is reduced but continues annually until the child is 72 months old.

The change in definition of lead toxicity and the above recommendations have refocused attention on one of the most common pediatric health problems in the United States. At this institution located in a remote rural area, it was suspected that the population had little contact with environmental lead; therefore, the increased lead screening would likely add expense but make little difference in the health of these pediatric patients. Two of the major sources of lead exposure, leaded gasoline fumes and lead-based paint, were not prevalent; few houses were located near heavily traveled roads, most roads were not paved, and the majority of homes in the service area were built after 1960. Furthermore, there was concern that children labeled as "high risk" because of a yes answer to one or more of the five questions would be subjected to an unnecessary blood draw at that time and also subjected to at least two more blood lead level determinations and yearly testing until age 6.

The purpose of this study was to measure the local prevalence of elevated blood lead levels (EBLL) in children between the ages of 6 months and 6 years and to determine the utility of the CDC's lead screening questionnaire in this rural population.

METHODS

Participants in this consecutive series study were from the 1800-square-mile service area of Ganado, Arizona, on the Navajo Reservation. The majority of the subjects were from low-income families (1990 average per capita income was reported to be $4106), and were Indian Health Service beneficiaries or had medical insurance through the Arizona Health Care Cost Containment System. Testing was done at no cost to the patients.

From November 1993 to September 1994, a total of 376 children aged 6 to 72 months seen consecutively in the outpatient department for well-child care were tested for lead poisoning and administered the CDC lead screening questionnaire. Three hundred sixty-eight usable blood samples were obtained by venipuncture; three samples were lost, one clotted, and four were not drawn. The blood levels of the usable samples were measured by anodic voltammetry at the Nichol's Institute in El Paso, Texas. An elevated blood lead level (EBLL) was defined as a concentration [is greater than or equal to] 10 [micro] g/dL. The CDC lead screening questionnaire, with an additional two questions, was completed for each child (Table 1). Questions 6 and 7 were added to reflect local conditions. Most questionnaires were conducted by a physician or mid-level provider. A Navajo interpreter assisted with the questionnaire when necessary.

TABLE 1 Questionnaire Used to Determine the Risk of Lead Poisoning in Children from a Rural Population

```
1. Do you live in, or regularly visit, a house with peeling or
chipping paint, built before 1960? This could include a day-care
center, preschool, home of a babysitter, a relative, etc.

2. Do you live in or regularly visit a house built before 1960
with renovation or remodeling that is ongoing or was done within
the past 12 months?

3. Do you have a brother or sister, a housemate, or a
playmate with lead poisoning?

4. Do you live with an adult whose job or hobbies involve
exposure to lead?

5. Do you live near an active lead smelter, battery recycling
plant, or other industry likely to release lead?

6. Do you have contact with any other sources of lead? If
yes, specify:

7. Do you live near a heavily traveled road?
```

Based on the Centers for Disease Control and Prevention lead screening questionnaire.(2) Questions 6 and 7 were added for the purposes of this study.

RESULTS

There were 368 subjects (189 boys, 179 girls) who had blood level measurements. The average age of these children was 30.5 months, and 362 (98.4%) were Navajo. Eight children had blood levels of [is greater than or equal to] 10 [micro] g/dL for a prevalence of 2.2%. When lead level testing was repeated in six of the eight subjects, only one (EBLL = 21 [micro] g/dL) had a confirmed elevated level (13 [micro] g/dL). Of the remaining five children who had repeat, lead level tests, three had levels [is less than] 5 [micro] g/dL and two had levels of 6 [micro] g/dL and 9 [micro] g/dL, respectively. The distribution of lead levels is found in the Figure. The age range of children with EBLL was 11 to 67 months, with a median of 25.5 months and a mean of 31.9 months of age.

[Figure ILLUSTRATION OMITTED]

Of the 368 children tested for EBLL, 323 (87.8%) completed the questionnaires. Eighty-three children with blood lead levels [is less than] 10 [micro] g/dL had positive CDC questionnaire results. Thus, 83 of 323 (25.7%) subjects had false-positive questionnaire results. Of the eight children with EBLL, one did not complete a questionnaire, three had positive questionnaire, results, and four had false-negative results.

The sensitivity and specificity of the CDC questionnaire were 42.9% and 73.7%, respectively, with a positive predictive value of 3.5%. The additional two questions did not improve the predictive value of the questionnaire (Table 2).

TABLE 2 Performance of Lead Screening Questionnaire

Questionnaire and Components	Sensitivity, %	Specificity, %
CDC's original questionnaire(*)	42.9	73.7
CDC's original questionnaire with additional questions 6 and 7([dagger])	42.9	66.1
"Home" questions 1 and 2 only([double dagger])	14.3	83.9

Questionnaire and Components	PPV, %	NPV, %
CDC's original questionnaire(*)	3.5	98.3
CDC's original questionnaire with additional questions 6 and 7([dagger])	2.7	98.1
"Home" questions 1 and 2 only([double dagger])	1.9	97.8

PPV denotes positive predictive value; NPV, negative predictive value.

(*) The Centers for Disease Control and Prevention 5-item questionnaire to determine EBLL risk in children.(2)

([dagger]) Questions 6 and 7 were added by the author of this study in an attempt to improve the utility of the questionnaire by reflecting the specific locale.

([double dagger]) The "home" questions are questions 1 and 2 on the original CDC questionnaire that ask whether a child lives in house built before 1960, and if so, whether recent renovations have been done to the house.

DISCUSSION

This study found a low prevalence of EBLL (2.2%) as compared with the third National Health and Nutrition Examination Survey (NHANES III, 1988 to 1991), which identified a prevalence of 8.9% in 1- to 5-year-old children.(3) Such a low lead burden was probably multifactorial. In the United States, lead-based paint (used primarily in homes built before 1960) provides the highest concentration of lead now that most gasoline is unleaded and lead has been removed from soldered cans.(2,4) A review of the Navajo Nation 1990 census data revealed that only 15% of homes were built before 1960 and more than 50% were constructed during the 1980s.(5) This statistic alone may indicate why so few children had EBLL.

Leaded gasoline was sold in the area during the time of this study, and although there are only four paved roads in the region, it was felt that this represented the greatest potential source of lead in the area. Therefore, % question was added to the questionnaire about living near a busy road. However, no child whose parent answered yes tested positively for EBLL. Other potential sources of lead include living in proximity to silversmithing, pottery production, or automotive repair work. Common Navajo traditional medications do not contain lead.

The CDC lead screening questionnaire performed poorly in the study. It had a sensitivity of only 42.9%, specificity of 73.7%, and a positive predictive value of 3.5%. Retrospectively, if the completed questionnaires had been used to determine which children were at risk, 86 children would have had their blood tested. Of these 86, only three tested positive for EBLL (10, 11, 11 [micro] g/dL). The questionnaire failed to indicate four of the seven actual cases of EBLL. Additionally, the 83 (25.7%) children, despite having normal lead levels, would have been required to undergo repeat blood tests at 6 and 12 months, then annually until 6 years of age. The questionnaire failed to indicate four of the seven actual cases of EBLL.

Other studies evaluating the utility of the CDC lead screening questionnaire have produced mixed results, with sensitivities ranging from 63.6% to 87%.(6-11) It has been suggested that the questionnaire is most sensitive in communities, such as in this study, where few houses were built before 1960.(9) The findings of this study, however, do not support this assertion, as it had the lowest questionnaire sensitivity (42.9%) of those reported.

Some studies that evaluated the usefulness of the CDC questionnaire have successfully modified the questionnaire by defining questions specific to their communities.(6,7,9,10) In this study, two questions were added to the standard CDC questionnaire to tailor it to the area in question and improve its utility. However, the addition of questions 6 and 7 in the study produced a decline in the specificity and predictive values (Table 2). In studies where the "home" questions were isolated for evaluation, or when some variation of them was used, it had equal or better sensitivity than the entire CDC questionnaire (See footnote [dagger] on Table 2).(7,10,11) In a population with a similar prevalence of lead poisoning as in this study (2.1%), Binns et al(7) improved the sensitivity of the CDC questionnaire from 69% to 83% by asking if the child lived in a house built before 1960.(7) Tejeda et al,(11) found that an affirmative answer to either of the CDC's "home" questions had a sensitivity of 87%, the same as the entire questionnaire. In the study reported here, if only questions 1 and 2 about the home were asked, the sensitivity declined from 42.9% to 14.3% (Table 2).

This study was limited by the time interval between initial and repeat tests, which ranged from 20 days to 114 days. What effect the longer delays had in retesting is unknown. When six of the eight children with EBLL were retested, only one had a confirmatory positive test. Therefore, the actual prevalence of EBLL may have been even lower.

Another limitation of the study was that it did not define the term "close to" in question 7. Other studies have used the Cutoff Of 100 ft.(7) It was hypothesized that the greatest risk for lead toxicity in this population was exposure to leaded gasoline and unintentionally limiting the distance was a concern because it may have negated a risk-identifying factor. Of the 46 children whose parents answered yes to question 7, none had an elevated blood level. Retrospectively, if a cutoff of 100 ft was used, only four (instead of 23) children would have produced positive questionnaires based solely on question 7. This modification would have refined the "adapted" questionnaire used in this study, but would not have represented an improvement over the CDC questionnaire.

CONCLUSIONS

Physicians who screen children for lead poisoning should know the local prevalence of lead poisoning before using the CDC lead screening questionnaire. If there is little lead poisoning in their community, universal screening with the lead screening questionnaire may result in children undergoing unneccesary blood tests for lead levels. This discomfort to the children, extra expense, and time spent completing the questionnaire might be safely avoided in some communities.

ACKNOWLEDGMENTS

The author would like to thank Pat Bullock, RN, the outpatient department staff, and Ms Eva Grabarek for their invaluable support; and Anthony F. Valdini, MD, for his assistance with reviewing the manuscript and Roger Gollub, MD, for providing the figure.

REFERENCES

(1.) Ruff HA, Bijur PE, Markowitz M, Ma YC, Rosen JF. Declining blood lead levels and cognitive changes in moderately lead-poisoned children. JAMA 1993; 269:1641-6.

(2.) Centers for Disease Control. Preventing lead poisoning in young children: a statement by the Centers for Disease Control. Atlanta, Ga: Centers for Disease Control, 1991.

(3.) Brody DJ, Pirkle JL, Kramer RA, et al. Blood lead levels in the US population: phase 1 of the third National Health and Nutrition Examination Survey (NHANES III, 1988 to 1991). JAMA 1994; 272:277-83.

(4.) Pirkle JL, Brody DJ, Gunter EW, et al. The decline in blood lead levels in the United States: the National Health and Nutrition Examination Surveys (NHANES). JAMA 1994; 272:284-91.

(5.) Navajo National Profile. Updated Summary. Division of Community Development, Navajo Tribe, 1993.

(6.) Rooney BL, Hayes EB, Allen BK, Strutt PJ. Development of a screening tool for prediction of children at risk for lead exposure in a midwestern clinical setting. Pediatrics 1994; 93:183-7.

(7.) Binns HJ, LeBailly SA, Poncher J, Kinsella TR, Saunders SE, Pediatric PRG. Is there lead in the suburbs: risk assessment in Chicago suburban pediatric practices. Pediatrics 1994; 93:16471.

(8.) Schaffer SJ, Szilagy PG, Weitzman M. Lead poisoning risk determination in an urban population throuh the use of a standardized questionnaire. Pediatrics 1994; 93:159-63.

(9.) Dalton MA, Sargent JD, Stukel TA. Utility of a risk assessment questionnaire in identifying children with lead exposure. Arch Pediatr Adolesc Med 1996; 150:197-202.

(10.) Striph KB. Prevalence of lead poisoning in a suburban practice. J Fam Pract 1995; 41:65-71.

(11.) Tejeda DM, Wyatt DD, Rostek BR, Solomon WB. Do questions about lead exposure predict elevated lead levels? Pediatrics 1994; 93:192-4.

Submitted, revised, September 15, 1997. From the Navajo Health Foundation, Sage Memorial Hospital, Granado, Arizona, and the Department of Family and Community Medicine, Baylor College of Medicine, Houston, Tex. Requests for reprints should be addressed to Louis A. Kazal, Jr, MD, Navajo Health Foundation, Sage Memorial Hospital, PO Box 457, Ganado, AZ 86505.