Do Questions About Lead Exposure Predict Elevated Lead Levels?

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ABSTRACT. ***Objective.*** **To assess the usefulness of the lead poisoning questionnaire developed by the Centers for Disease Control and Prevention as a screening tool for elevated lead levels.**

Methods. **This descriptive study used a five-question questionnaire at our hospital-based general pediatric clinic and in two local private practices. We obtained venous lead levels from 485 children aged 9 months to 6 years who were brought for health supervision visits. The questionnaire was completed by a primary caretaker of 330 patients (68%). Contingency tables were used to compare lead levels with the responses on the questionnaire.**

Results. **Lead levels of ≥10 µg/dL were found in 23 (7%) of 330 who completed the questionnaire. Caretakers of children with elevated lead levels were more likely to answer yes to questions about chipping paint and home remodeling than those whose children had levels <10 (P = .0001). These questions had sensitivities for detecting elevated lead levels of 70% and 74% with negative predictive values of 97% and 98%, respectively. Questions about known contacts with lead poisoning and job or industrial exposure to lead each had sensitivities of <10%. The Centers for Disease Control and Prevention's definition of high risk for lead poisoning (one or more positive responses) was nearly 90% sensitive for detecting elevated lead levels with a negative predictive value of 99%.**

Conclusion. **This risk assessment questionnaire is an effective screening method for elevated lead levels in our population. Questions about the home environment were more sensitive indicators of elevated lead levels than other standard high-risk questions.** ***Pediatrics*** **1994;93:192–194;** ***infants and children, screen for lead poisoning.***

ABBREVIATIONS. EBPb, elevated blood lead levels; BPb, blood lead; CDC, Centers for Disease Control and Prevention.

Elevated blood lead levels (EBPb) are known to cause a wide range of health problems in infants and children.[1-3] Recent studies suggest that blood lead (BPb) levels previously considered safe may have deleterious effects on several neurobehavioral parameters.[4-10] In October 1991, as a result of this mounting body of evidence, the Centers for Disease Control and Prevention (CDC) lowered the intervention level for BPb from 25 µg/dL (1.206 µmol/L) to 10 µg/dL (0.483 µmol/L) and recommended universal BPb testing of children aged 9 months to 6 years.[11]

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The CDC also suggested using a five-question questionnaire to assess patient risk of high-level lead exposure. Children at high risk (defined by the CDC as a positive response to one or more questions) are advised to have earlier and more frequent BPb testing than children at low risk. The questionnaire was not meant to replace BPb testing as a primary screening tool.[11]

In 1991 the San Francisco Department of Public Health obtained BPb levels on 1199 children. BPb levels of ≥10 µg/dL (0.483 µmol/L) were found in 8% of these children.[12] In spite of this finding, many pediatricians and family physicians practicing in San Francisco surveyed in 1992 believed that universal screening was unwarranted. Many used the CDC's questionnaire as a primary screening tool (unpublished data). The objective of our study was to assess the usefulness of the CDC's questionnaire as a screening tool. We hypothesized that in our population the questionnaire would be sensitive enough to use as a primary screening method.

METHODS

We obtained venous lead levels from children aged 9 months to 6 years who were brought for health supervision visits to our hospital-based general pediatric clinic or to the offices of two local pediatricians during a 15-month period. Some eligible children were not screened. This was mainly due to parental refusal or inability to obtain venous access. All lead levels were obtained at a single approved laboratory using flameless atomic absorption. EBPb was ≥10 µg/dL (0.483 µmol/L) in accordance with the CDC recommendations.[11] The study was approved by our hospital Institutional Review Board.

The CDC's questionnaire was completed by a primary caretaker of the child (Table 1). This was performed directly by the caretaker at the time the lead level was obtained or retrospectively by telephone interview with one of the first two authors. Contingency tables were used to compare lead levels with responses to the questions and with several demographic variables using STATVIEW II software.

RESULTS

BPb was obtained from 485 children. Three hundred eight (64%) patients were from our hospital-based clinic. Three hundred thirty (68%) patients had private insurance and 155 (32%) had Medicaid or no insurance. Nearly half of our patients were 12 to 23 months old, and 75% were younger than 36 months of age (Table 2).

Twenty-eight patients (6%) had EBPb. Twenty-three patients (5%) had levels between 10 and 14

TABLE 1. Risk Assessment Questionnaire

1. Does you child live in or regularly visit a home or other location built before 1960 with chipping or peeling paint?
2. Does your child live in or regularly visit a home or other location built before 1960 which has been recently remodeled?
3. Does your child have any relatives or friends who have been diagnosed with lead poisoning?
4. Does your child live with anyone whose job or hobby involves exposure to lead (such as painting, soldering, auto battery manufacturing or recycling, auto radiator repair)?
5. Does your child live near an active lead smelter, battery recycling plant, or other industry likely to release lead?

Source: Reference 11.

TABLE 2. Age Distribution and Prevalence of Elevated Blood Lead Levels (EBPb) by Age

Age, mo	Patients Screened n (% of Total)	Patients With EBPb n (%)
9–11	65 (13)	1 (1.5)
12–23	213 (44)	14 (6.6)
24–35	82 (17)	9 (11)
36–47	72 (15)	3 (4)
48–59	34 (7)	1 (3)
60–72	19 (4)	0
Totals	485 (100)	28 (6)

μg/dL (0.483 and 0.676 μmol/L); five patients (1%) had levels between 15 and 18 μg/dL (0.724 and 0.869 μmol/L). There were no patients with levels of ≥19 μg/dL (0.917 μmol/L).

The differences in prevalence of EBPb between clinic patients (20/309, 6.5%) and private patients (8/76, 4.5%), as well as between insured (17/348, 4.9%) and uninsured patients (11/137, 8%) were not statistically significant. The prevalence of EBPb varied by age from a high of 11% in 24- to 35-month-olds to a low of 0% in children 60 months and older (Table 2).

The questionnaire was completed by a primary caretaker of 330 patients (68%). Twenty-three (7%) of these patients had EBPb. Questionnaires were not completed for 155 patients (32%) because we were unable to reach their caretakers. Of the 330 completed questionnaires, 150 (45%) were completed at the time the BPb was obtained. The remaining 180 were completed retrospectively by telephone interview. A comparison of our study group of 330 patients with our total population of 485 patients revealed a similar prevalence of EBPb (7% vs 6%); age distribution (71% vs 74% younger than age 3); and insurance status distribution (66% vs 68% privately insured).

The results of the statistical analysis of each question are summarized in Table 3. Children whose caretakers answered yes to either question regarding the home environment (chipping paint or remodeling) were significantly more likely to have EBPb than children whose caretakers answered no to these questions. The sensitivity to detect EBPb was 70% for the chipping paint question and 74% for the remodeling question. The negative predictive values were 97% and 98%, respectively. Questions about known contacts with EBPb, job exposure, and industrial exposure each had sensitivities of <10%.

There was a trend (not statistically significant) toward an increasing prevalence of EBPb with an increasing number of positive responses on the questionnaire. No patient responded yes to all five questions. Neither of the two patients with four positive responses had EBPb. Four (67%) of six patients with three positive responses had EBPb. Nine (28%) of 32 patients with two positive responses and 7 (12%) of 57 patients with one positive response had EBPb. Three (1%) of 233 patients with all negative responses had EBPb.

Using the CDC's definition of high risk for EBPb (yes to at least one question), the questionnaire had a sensitivity for detecting EBPb of nearly 90% with a negative predictive value of 99%. Using only the two questions regarding the home environment was as sensitive a screening tool as using all five questions (Table 4).

We separately analyzed the 180 retrospective and the 150 prospective questionnaires. These two groups were similar to each other and to our entire population of 485 patients with regard to prevalence of EBPb, age distribution, and insurance status distribution. The sensitivity for detecting EBPb was 100% in the prospective group using the CDC's definition of high risk. This same definition of high risk was 72% sensitive for EBPb in the retrospective group. The chipping paint and home remodeling questions were each 100% sensitive for EBPb in the prospective group. These two questions each had a sensitivity of 55% in the retrospective group.

DISCUSSION

In our urban, primarily middle class population, the prevalence of EBPb was 6%. Privately insured patients and those with Medicaid or no insurance had similar prevalences. This suggests that in San Fran-

TABLE 3. Analysis of Questionnaire Results

Question*	Sensitivity†	Specificity†	Positive Predictive Value†	Negative Predictive Value†	*P* Value
1. Chipping paint	70	86	27	97	.0001
2. Remodel	74	85	27	98	.0001
3. Contacts with EBPb	9	98	29	94	.0233
4. Job exposure	4	96	8	93	.9169
5. Industry	4	99	25	93	.1542

* Refer to Table 1 for entire question. EBPb = elevated blood lead level.
† Values given are percentages.

TABLE 4. Combined Questions

Question	Sensitivity*	Specificity*	Positive Predictive Value*	Negative Predictive Value*	*P* Value
Yes to at least one question†	87	75	21	99	.0001
Yes to at least one home question‡	87	77	22	99	.0001

* Values given are percentages.
† From entire questionnaire.
‡ Chipping paint and/or remodeling questions.

cisco EBPb levels are not solely a problem of children of lower socioeconomic status.

The CDC questionnaire is an effective screening tool for EBPb in our population. The questionnaire's sensitivity for detecting EBPb approached 90% with a specificity of 75%. A child who answered no to all five questions had only a 1% chance of having an EBPb. Our data support the CDC recommendation of earlier and more frequent blood testing of children who answer yes to at least one question. It also suggests that in our population BPb testing is not indicated for children younger than 1 or older than 3 years of age when there are negative answers to all questions.

Analysis of individual questions revealed that home environment questions were more sensitive indicators of EBPb than other questions. Questions about chipping paint and remodeling, when used together, were as effective a screening tool as using all five questions. In areas of the country with more lead-related industries, questions about job and industrial exposure might be more useful. Similarly, in areas with a higher prevalence of EBPb, a question about known contacts with EBPb may be a more sensitive screening method.

A weakness of our study is that half of the questionnaires were completed retrospectively by telephone interview. This may have introduced bias in several ways. Caretakers who know their child's BPb may answer questions differently. Such caretakers may think more about sources of lead exposure. Secondly, the unblinded interviewer may introduce bias. We attempted to control for this by having the interviewer read the questions directly from the questionnaire. The greater sensitivity of the prospectively completed questionnaires suggests that this potential bias did not play a significant role.

At present, therapy for children with BPb between 10 and 20 μg/dL (0.483 and 0.965 μmol/L) is limited to education and efforts to remove sources of lead in the child's environment. At a charge of $10 to $30 per BPb test, universal testing is expensive. Alternatively, the harm to children due to elevated lead levels may be economically and socially costly. Use of a history screen might help avoid a painful procedure for some infants and an economic cost to society. In our population the two home environment questions from the CDC risk assessment questionnaire are sensitive enough to use as the primary screening method for EBPb. We recommend further studies in various geographical areas.

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