Are Pediatricians Ready for the New Guidelines on Lead Poisoning?

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ABSTRACT. In 1991 the Centers for Disease Control established new guidelines for the definition of and screening for lead poisoning.

Objective. **To assess: (1) pediatricians' knowledge of lead poisoning including the most recent literature on the subject, and (2) their screening practices.**

Design, setting, subjects. **A 22-item questionnaire was developed and validated. The survey was mailed to 1183 physicians in Virginia who were self-designated as pediatricians in the state medical registry.**

Results. **Sixty-nine percent (391/556) of those responding practiced primary care and 27% (153/556) were subspecialists. They were evenly distributed throughout the state. Of the respondents, 62% were male, 86% were white, and 72% trained at a university program. The median year for training completion was 1978. Demographic differences were not demonstrated (χ^2) between primary care pediatricians and subspecialists.**

Responses demonstrated an overall deficiency in physicians' knowledge of lead poisoning with specific deficiencies in knowledge of the literature, with mean ± SD correct responses of 15.7 ± 3.4. Primary care pediatricians scored significantly better than subspecialists: 16.2 ± 3.0 vs 14.7 ± 4.1 ($P < .001$, *t*-test). Twelve percent of the total group and 13.5% of primary care physicians were screening all their patients.

Conclusions. **Although primary care pediatricians (self-designated) are more knowledgeable about lead poisoning than their subspecialist colleagues, there are still deficiencies, and screening practices must be modified in both groups. To successfully implement the new Centers for Disease Control and Prevention guidelines, physician education must be a priority.** ***Pediatrics*** **1994;93:178–182;** ***lead poisoning, physician education, questionnaire.***

ABBREVIATION. CDC, Centers for Disease Control and Prevention; BPb, blood lead.

Lead poisoning is the most common environmental pediatric health problem in the United States.[1] Multiple studies have demonstrated a clear correlation between low-level lead exposure during early development and deficits in neurobehavioral-cognitive performance that manifest later in childhood.[2–11] These deficits, including IQ deficiency, behavioral disorders, and impaired hearing, have been associated with blood lead levels as low as 10 μg/dL (0.48 μmol/L).[4,8,12] As a direct result, in October 1991 the Centers for Disease Control and Prevention (CDC) published guidelines on the level of blood lead (BPb) thought to be toxic, reducing the standard from 25 μg/dL (1.21 μmol/L) to 10 μg/dL (0.48 μmol/L), thus redefining childhood lead poisoning.[12] This decrease in the designated toxic level has significantly increased the number of children who are now considered to be lead poisoned. Furthermore, results from longitudinal studies have demonstrated that the negative effects of lead on cognitive function are persistent across cultures, racial and ethnic groups, and social and economic classes.[13]

It is estimated that 14 million children less than 7 years of age are at high risk because they live in homes built before 1959. These homes contain the greatest amounts of lead-based paint, the number one environmental source of lead for children.[1] Estimates from 1984 (the last year for which national estimates are available) show that between 3 and 4 million children younger than 6 years (17% of all US children in this age group) had BPb levels >15 μg/dL (0.72 μmol/L).[1] Additionally, these data estimate that about 40% of US white children between the ages of 6 months and 5 years have BPb levels >10 μg/dL (0.48 μmol/L).[2,12] Interestingly, the usual increased prevalence of selected conditions between poor black children when compared with white children of a similar socioeconomic status is reversed in the case of lead poisoning. In this case, the prevalence of white children with BPb levels >10 μg/dL (0.48 μmol/L) is 68.2%, whereas that of black children is 55%.[2,12]

In conjunction with the new standards for lead intoxication, the CDC also developed new guidelines for screening for lead intoxication, following up children with significant lead burden, and initiating primary prevention of lead poisoning. The major goals for these guidelines include universal screening for all children 6 years of age or less and the measurement of BPb levels as the standard for screening.[12] Physicians must be knowledgeable about childhood lead poisoning to follow the new guidelines.

To assess pediatricians' knowledge of lead poisoning including their knowledge of the most recent literature on the subject and to determine their screening practices, we conducted a survey of pediatricians in the Commonwealth of Virginia. We hypothesized that pediatricians were not current in their knowledge of lead poisoning or of the new CDC guidelines, and that their screening practices were not in accord with the new CDC recommendations.

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METHODS

A written questionnaire was developed which included 22 questions to measure knowledge, 7 questions to document screening practices, and 8 questions to collect demographic information. Questions assessing knowledge were constructed from recent literature on the subject of lead poisoning.[1,3,5–10,14] These questions were close-ended, with responses formatted using a Likert-type scale (Table 1). For the purpose of calculating a respondent's score, the scale was dicotomized to "correct" and "incorrect." According to the question's structure a "correct" response was defined as *either* "agree" and "strongly agree" *or* "disagree" and "strongly disagree"; a "don't know" response was considered to be incorrect. Questions documenting screening practices addressed methods of screening used, numbers of patients screened, types of patients screened, and the level of lead considered to be of concern (Table 2). Demographic questions included gender, race, geographic location, type of residency training, year training completed, current type of practice, journals read, and continuing medical education programs attended. Information regarding board certification and physician acceptance of Medicaid patients was not obtained.

The questionnaire was validated in a pilot study of 50 pediatricians randomly selected from the American Academy of Pediatrics membership list representing a variety of clinical settings outside of Virginia. There was a 64% response rate in the pilot study. The information obtained from the knowledge questions corresponded to what was expected based on the construct of the questions. From these responses, a few changes were made in the questionnaire (none relating to the knowledge questions). Questionnaires were then mailed, coincident with the publication of the CDC guidelines, to 1183 Virginia physicians listed as pediatricians by the State Board of Medicine. (A listing by the State Board of Medicine does not ensure that the physician is a pediatrician by training. The State Board has no records that track training with specialty listed. The American Academy of Pediatrics, however, lists its Virginia membership of board-certified pediatricians as approximately 740.)

Questionnaires were coded and completed anonymously. Self-addressed, stamped envelopes were included for ease of returning the survey. Two additional mailings (at 2-month intervals) of the questionnaires were sent to those who did not respond to the first or second mailings.

Data were analyzed by χ^2, analysis of variance, and two-tailed *t*-test. Level of significance was set a priori at $P < .05$.

RESULTS

Six hundred and sixty-one (56%) of the surveys were returned after three mailings. Of the total surveys returned, 556 (47%) could be used for general analysis and 522 (44%) could be used for specific comparisons between primary care and subspecialty pediatricians. Excluded surveys consisted of incomplete forms and those from retired physicians.

Demographic Characteristics (Table 3)

Sixty-nine percent of the respondents practiced primary care, and 27% were subspecialists. They were distributed throughout the state corresponding to the population distribution in Virginia. Of the respondents, 62% were male, 86% were white, and 70% attended a university training program. The median year for training completion was 1978. Demographic differences by χ^2 were not demonstrated between the primary care pediatricians and the subspecialists.

Knowledge

Responses demonstrated an overall deficiency in physicians' knowledge with specific deficiencies in knowledge of the literature. Correct responses ranged from 1 to 22 (of a possible 22) with a mean and standard deviation of 15.7 ± 3.4. To determine whether a relationship existed between knowledge and the duration of potential exposure to the new CDC guidelines, we stratified the responses according to the mailing from which they were received. The mean scores and standard deviations for the first, second, and third mailings were 15.9 ± 3.1, 15.5 ± 3.5, and 14.3 ± 4.3, respectively. Analysis of these results by analysis of variance demonstrated a significant ($P < .01$) difference in knowledge among the three groups. This difference, however, was not in the direction anticipated. In this study, the last group responding had the lowest mean score. Therefore, an increase in knowledge with presumptive exposure to the guidelines was not manifested. There was no significant difference found in pediatricians' knowledge when the scores were analyzed by region (analysis of variance).

TABLE 1. Examples of Knowledge Questions

	Strongly Disagree	Disagree	Don't Know	Agree	Strongly Agree
1. Lead poisoning is still a problem for today's children.	1	2	3	4	5
2. The CDC* currently defines lead poisoning as a blood lead of >25 μg/dL.	1	2	3	4	5
3. Lead-based paint is still the number one source of lead for children.	1	2	3	4	5
4. Removal of lead from gasoline has eliminated the problem of lead poisoning in children.	1	2	3	4	5
5. Children with lead poisoning are all symptomatic.	1	2	3	4	5
6. The major effect of lead is on the central nervous system of the child.	1	2	3	4	5
7. Lead cannot affect the unborn child.	1	2	3	4	5
8. Learning disabilities and decreased cognitive functioning are the major manifestations of lead poisoning.	1	2	3	4	5
9. Lead poisoning is a problem only of poor, black, urban children.	1	2	3	4	5
10. Despite banning lead-based paint in 1978, 12 million children, less than of 7 years old are at risk for exposure to lead.	1	2	3	4	5

* CDC = Centers for Disease Control and Prevention.

TABLE 2. Examples of Screening Practice Questions

1. I screen children for lead poisoning.	___ All	___ Some	___ None
2. I screen children using an EP* or ZNP level.		___ No	___ Yes
3. I screen children using a capillary lead level.		___ No	___ Yes
4. If the answer to question 1 was some, which children are screened?			
___ High-risk environment			
___ Anemia			
___ Behavioral problems			
___ Other _____			
5. At what lead level are you concerned? (Check one only.)			
___ 10 μg/dL			
___ 15 μg/dL			
___ 20 μg/dL			
___ 25 μg/dL			
___ 30 μg/dL			
___ >35 μg/dL			

* Abbreviations used are: EP, erythrocyte protoporphyrin; zinc protoporphyrin.

TABLE 3. Demographic Characteristics of Respondents (n = 556)

	n (%)
Primary care practice*	391 (69)
Subspecialty practice	153 (27)
Demographic distribution in Virginia	
Northern	175 (31)
Central	113 (20)
Eastern	130 (23)
Southwest	74 (13)
Northwest	74 (13)
Male gender	232 (62)
White race	487 (86)
University training program	396 (70)
Median year training completed	1978

* Includes private practice (solo and group), health maintenance organization, public sector practices.

Of the 22 knowledge questions, there were 11 questions that fewer than 75% of the pediatricians answered correctly. Deficiencies were found in the following areas: level of blood lead thought to be toxic (three questions), sources of lead (three questions), screening for lead (two questions), effect of lead poisoning (two questions) and treatment of lead poisoning (one question).

The scores of the primary care pediatricians were compared with those of the subspecialists. (For this analysis, aggregate data from all mailings were used.) The number of correct responses of the primary care pediatricians ranged from 1 to 22 with a mean of 16.0 ± 3.3, whereas the number of correct responses from the specialists ranged from 6 to 22 with a mean of 14.8 ± 3.6. The difference ($P < .001$) between the two groups was significant by two-tailed t-test.

Screening Practices

Only 11.7% of responding Virginia pediatricians were screening all their patients for lead poisoning. Sixty-three percent screened some of their patients and 25% did not screen any of their patients. Only 13.5% of primary care pediatricians and 5.6% of subspecialists routinely screened all their patients (Fig 1). Even though primary care pediatricians were screening significantly more children ($P < .01$), 13% were not screening any of their patients.

Blood lead level measurements were used by 49.8% of pediatricians when screening their patients for lead poisoning. There were still 47% of pediatricians who continued to screen their patients by measuring erythrocyte protoporphyrin levels. In Virginia there are two main laboratories, both classified as CDC reference laboratories, that are used for lead screening. Access to either laboratory by a physician's office is routine. Both laboratories are equipped to receive fingerstick specimens to analyze for blood lead levels.

Finally, as already reported, responses in the knowledge section demonstrated that pediatricians in Virginia did not agree on the specific level of BPb

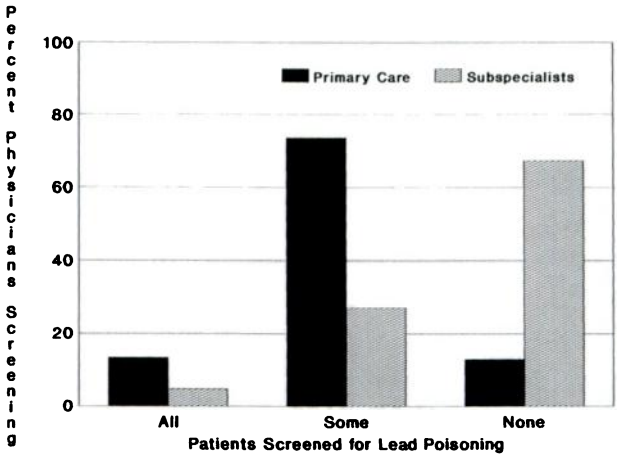

Fig 1. Percent of responding pediatricians screening their patients for lead poisoning.

which should be considered toxic. Although the majority of these pediatricians demonstrated concern at BPb levels <25 μg/dL (1.21 μmol/L), there was no consensus on a level of blood lead for which concern should be expressed (Fig 2).

DISCUSSION

Analysis of data from this survey indicates that although primary care pediatricians are significantly more knowledgeable about lead poisoning than their subspecialist colleagues, serious deficiencies exist. The concentration of environmental lead to which children in the United States are exposed has decreased in the last decade. This decrease is primarily a reflection of the removal of lead from gasoline and house paint, as well as the elimination of lead solder from the seams of food and beverage containers and the joints of plumbing fixtures.[13] Although these changes have lowered the potential lead burden of the overall population, lead intoxication remains a serious problem for children because multiple other sources of lead still exist in the environment. Because lead remains unchanged in its elemental form, dirt contaminated by lead from automobile emissions (pre-unleaded gasoline) and from the destruction of substandard houses (containing lead-based paint) is still a very real problem. It is estimated that 16% of American homes have water containing lead at levels that are greater than those approved by the Environmental Protection Agency.[15] Miscellaneous sources include colors used in the comics (red, green, yellow), cultural home remedies (azarcon, greta, pay-loo-ah), ceramic tableware, cosmetics (kohl and surma), and dust brought in by family members working in leaded environments not changing clothing before returning home.[14] Pediatricians need to become familiar with the various sources of lead other than paint and paint dust to help their patients identify potential environmental hazards and avoid exposures.

Children with low-level lead poisoning are asymptomatic. The effects of lead poisoning, however, are significant not just to individual children, but to society at large. In a long-term follow-up study, Needleman demonstrated that children with high tooth lead levels in grade school were seven times more likely not to graduate from high school, and six times more likely to have reading scores at least two grades lower than expected.[10] In addition, these children had higher absenteeism, lower class rank, decreased vocabulary skills, slower finger-tapping speed, and poorer hand-eye coordination.[10] Data from other studies were analyzed using meta-analysis. These data showed an average decrease of 0.25 IQ points for each 1.0 μg/dL (0.05 μmol/L) increase in BPb levels.[2] It has been estimated that in the United States, each reduction of 1.0 μg/dL (0.05 μmol/L) in a child's BPb level due to lead exposure abatement programs would result in a net savings to society of $2000 per child.[4]

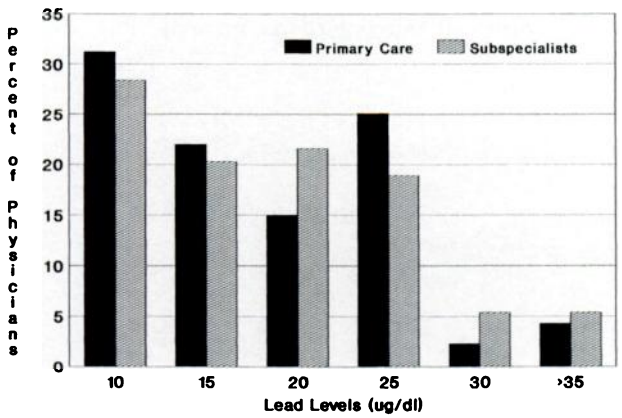

Fig 2. Percent of responding pediatricians concerned by specific blood lead levels.

As long as children are at risk for environmental exposure to lead, screening is crucial to prevent the significant effects of this exposure. Physicians responding to our questionnaire, however, are not in agreement as to the BPb level that should be defined as toxic or for which concern should be expressed. These pediatricians demonstrate great variability in their screening practices and methods of screening. Although the authors did not explore the relationship between pediatricians' lack of consensus and their screening practices and methods, one might speculate on the existence of such a relationship. To achieve the goals established by the CDC for both universal screening and blood lead measurements as the screening tool, screening practices, especially of the primary care pediatrician, must be improved. Subspecialists need to be included as screening physicians in as much as they are often called upon to evaluate children whose reason for referral may indeed be caused by lead toxicity. Examples of such referrals include: children with growth faltering, children with developmental and behavioral problems, and children with anemia. Therefore, until the demonstrated primary care pediatrician knowledge deficiency is corrected, subspecialists should to continue to screen their patients for lead burden, when appropriate.

Prevention of lead poisoning is also heavily dependent on the practice community.[12] Pediatricians need to educate their patients and their patients' families about environmental sources of lead and implement testing for BPb levels according to the established schedules.[12] Testing for BPb should become as routine as a tuberculin skin test, hematocrit, or immunization.[2] Moreover, pediatricians must be able to interpret the results of lead screening and arrange or provide the necessary interventions for lead-poisoned children. These interventions may include, but are not limited to, developmental assessment, environmental evaluation, repeat BPb testing, ongoing education, medical/pharmacologic therapy, and definitive environmental abatement.[12] In cases in which the physician is unable to manage his/her patient because of lack of facilities or support services needed to provide the necessary care, the patient may then be referred to a pediatric lead center.

One limitation of this study was the small sample size. The authors believe, however, that the responses are either broadly representative of pediatricians or reflective of a higher level of knowledge than generally exists in the physician community because these

physicians exhibited interest by returning their surveys. This interest may also explain the small difference in knowledge between primary care pediatricians and subspecialists. If interest represents a greater level of knowledge, then the knowledge deficiency is much more serious than we have described. In addition, we are reasonably certain, based on our national random sample pretest, that pediatricians in Virginia are no different than pediatricians elsewhere. Of course we would hope that pediatricians practicing in areas with a significant lead problem would be more knowledgeable on this subject and have more consistent screening patterns, but that is not indicated by the demographic analysis of results from Virginia.

To accomplish the tasks outlined above and successfully implement the guidelines established by the CDC, physician education on childhood lead poisoning must be a priority, and Continuing Medical Education courses must address these issues. Although it is known that increasing knowledge often does not alter behaviors, behaviors cannot be altered without an increase in knowledge. Before pediatricians can modify their behavior to include routine lead screening using BPb levels, the knowledge deficiency must first be corrected. Once the knowledge issue has been addressed, interventions to change behavior can be developed and implemented. In addition, critical review of the CDC's guidelines and their application must continue. Until revisions of the guidelines are released, state governments need to require universal screening and to work toward the development of an efficient and cost-effective process that will be available to all children.

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