COMMENTARY

Should Blood Lead Screening Recommendations Be Revised?

In October 1991, the Centers for Disease Control and Prevention (CDC) recommended blood lead (BPb) screening for virtually all 1-year-old children and, preferably, for all 2-year-old children as well.[1]

In April 1993, the US Department of Health and Human Services distributed guidelines recommending that all newborns, regardless of race or ethnicity, be screened for sickle cell anemia.[2]

In June 1993, the National Institutes of Health issued a consensus conference recommendation that all infants be tested for hearing impairment within the first 3 months of life, preferably before newborns leave the hospital.[3]

In each instance, these screening recommendations were developed because a group of experts, after identifying a child health problem within its area of interest, believed that universal screening was indicated. With national attention focused on controlling ever-rising health care expenditures, the contribution of screening to prevention should not be underestimated; nevertheless, the effectiveness of screening recommendations for each specific childhood disorder must be demonstrated, and the cost must be quantified and justified.

In this issue, Bess and Paradise comment on the inappropriateness of the recommendations for universal screening for hearing impairment.[4] The following comments offer a rationale for modifying current recommendations regarding BPb screening.

CURRENT CDC RECOMMENDATIONS

The 1991 CDC recommendations were issued because of an expanding body of knowledge about the effects of lead on the developing nervous system and because infrequent BPb screening resulted in failure to diagnose lead poisoning in many children.

In addition to recommending BPb screening, the CDC also recommends that specified questions be asked at all health supervision visits between ages 6 months and 6 years. These questions are designed to determine risk of lead exposure according to criteria provided by the CDC. For children at high risk, the CDC provides recommendations for screening frequency and follow-up activities.

For children not at high risk according to the questionnaire, the CDC recommends that all children have a BPb determination at age 1 year unless it can be shown that the community in which a child lives does not have a childhood lead poisoning problem. To demonstrate that a community lead problem does not exist, universal community screening is necessary.

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Any BPb >10 μg/dL is defined as lead poisoning, and it triggers an action. From 10 μg/dL through 14 μg/dL, the family should receive information, primarily to decrease exposure to lead-containing dust. Recommendations, in addition to repeat BPb testing in 3 months, include wet mopping hard surface floors and wiping window sills, baseboards, and other lead-containing surfaces at least weekly with a high-phosphate detergent cleanser. Also suggested are child hand-washing before eating and frequent washing of toys and pacifiers. The family should be educated about peeling paint and chewable surfaces that might contain lead-based paint. Additional recommendations address lead exposure from soil, drinking water, open food cans, pottery, and parental occupations or hobbies. Communitywide prevention efforts are recommended if many children have BPb levels in this range.

From 15 μg/dL through 19 μg/dL, any capillary BPb test should be confirmed with a venous BPb. In addition to the information given to families of children with BPb in the 10 μg/dL through 14 μg/dL range, individual case management and more frequent screening are recommended. If BPb does not decline, home visits and remediation are recommended, resources permitting.

Blood lead levels ≥20 μg/dL should initiate a more intense medical and environmental evaluation and remediation effort.

UNIVERSAL SCREENING REQUIREMENTS

For any universal screening program to be justified, it must meet several criteria.

- Screening must be for an important issue that has serious consequences if left unremediated.
- Abnormal results requiring intervention must occur with a frequency that justifies universal screening.
- An accurate and reliable screening test must be available.
- An effective intervention must be available.
- Advantages of screening must outweigh disadvantages.

Does the universal BPb screening program as recommended by the CDC meet these criteria?

Is lead poisoning an important issue with serious consequences if it is not remediated?

Severe lead poisoning (BPb >55 μg/dL) can result in encephalopathy with permanent damage. Substantial data indicate that moderate lead poisoning (25 μg/dL through 55 μg/dL) causes neurobehavioral and intelligence deficits. Although lead is a toxin with no apparent threshold below which it is harmless, the question is how much harm does BPb <20 μg/dL cause to the developing nervous system of a child? Because of a variety of confounding factors and because of an inability to correlate BPb at age 1 year with

cumulative body lead burden, evidence that BPb levels <20 μg/dL at age 1 year cause a clinically important decrease in intelligence and an increase in neurobehavioral problems by the time a child enters school is lacking.

Is the prevalence of BPb levels requiring intervention sufficient to justify universal screening?

Extrapolated data from 1984 indicating that 17% of all American preschool children had BPb levels >15 μg/dL was a factor in the rationale for the universal BPb screening recommended in 1991,[1] although the CDC recognized that lead exposure had decreased with more recent environment controls, including elimination of leaded gasoline.[5] In several nonselective programs, percentages of children from various parts of the country with BPb levels >10 μg/dL were considerably lower: Binns et al,[6] 2.1%; Nordin et al,[7] 2.5%; Tejeda et al,[8] 7%; and Rooney et al,[9] 9.5%. All are reported in this issue of *Pediatrics*. Preliminary data from the Third National Health and Nutritional Examination Survey (NHANES III), conducted from 1988 to 1991, found BPb levels in a range consistent with these values (Robert Murphy, MSHP, National Center for Health Statistics, personal communication). In addition, in 1992, of more than 200 000 California children living in poverty and tested for BPb, less than 0.3% had BPb >25 μg/dL.[10]

Considerably fewer suburban children than urban children have significantly elevated BPb. Levels >20 μg/dL were found in no more than 0.1% of suburban children in the Minneapolis/St. Paul and Chicago areas.[6,7] Gellert et al,[11] in a nonrandomized study of 5115 mixed urban and suburban children in Orange County, CA, reported that 0.3% of children had values >20 μg/dL.

Is there an accurate, reliable test to determine BPb?

Anodic stripping voltimetry and graphite furnace atomic absorption spectroscopy give BPb results with ±4 μg/dL accuracy provided that the laboratory is meticulous. Surveys, however, show that 10% to 20% of clinical laboratories do not meet proficiency standards.[12,13] This frequency of inaccuracy and of permissible variation may result in inappropriate advice for values <20 μg/dL. In addition, capillary screening, for which the CDC does not recommend venous confirmation when results are between 10 μg/dL and 15 μg/dL, may include skin lead contamination that falsely elevates BPb. Binns et al[6] reported that only 32% of 47 children with a capillary BPb >10 μg/dL had a confirmed venous BPb >10 μg/dL. Thus, one can question the accuracy of BPb values, particularly capillary values, between 10 μg/dL and 20 μg/dL.

Is there an effective intervention?

For intervention to be of value when BPb is <20 μg/dL, as recommended by the CDC, a series of events must occur.

Physician counseling regarding home dust control and child behavior modification must be implemented. These interventions must result in the reduction of BPb. The reduced BPb must result in significant neurobehavioral or intelligence improvement. For the individual child, the changes should be clinically significant. For public health, the changes should be not only statistically significant, but should represent a cost-effective use of health care funds.

Studies by Charney et al[14] and as reported in this issue by Kimbrough et al,[15] demonstrate that BPb can be reduced by house dust control as outlined in the CDC recommendations. The study by Charney et al demonstrated that child BPb levels ranging from 30 μg/dL to 49 μg/dL declined on average 6.9 μg/dL in a 1-year period. Children studied by Kimbrough et al showed an average decline of 7.8 μg/dL in 4 months with slight regression at 1-year follow-up. These children had initial BPb values ranging from 10 μg/dL to 35 μg/dL. No controlled studies to determine how much, if any, improvement among children with initial BPb <20 μg/dL have been reported.

No studies have evaluated the effect of office-based education and the use of educational material with families whose children have BPb levels between 10 μg/dL and 20 μg/dL. No prospective studies have evaluated an effect from reducing BPb of children with initial values <20 μg/dL. Until such studies are performed, the effect of the CDC intervention recommendations for children with BPb values <20 μg/dL remains speculative.

In the Charney study, home visits were made twice monthly to wet mop and to do other chores to reduce lead dust. In the Kimbrough study, home visits were made for dust and soil sampling and subsequently for discussion about home lead sources and child behavior factors. Neither study analyzed the cost of such labor-intensive home intervention, which would be of staggering magnitude were it to be performed for all children with BPb <20 μg/dL. Neither study evaluated neurobehavioral or intelligence changes subsequent to intervention. Kimbrough did not use a nonintervention control group.

The cost of interventions recommended by the CDC must be evaluated relative to individual and societal outcomes so that their value can be compared with that of other lead abatement efforts and so that the value of all lead abatement activities can be compared with that of other disease prevention activities.

Do the advantages of universal screening outweigh the disadvantages?

Negative consequences to the family include an invasive procedure, cost of screening and of retesting, lost work time, false positives, and parental anxiety. Disadvantages for society include failure to test those children who are probably at greatest risk (those not receiving health supervision), use of limited personnel time, the need to develop laboratories with the capacity to screen all children, and the financial cost to the health system with a diversion of resources from more cost-effective preventive projects.

The primary advantage of universal screening, in contrast to selective screening, is that no children with lead poisoning requiring medical therapy will be missed.

In summary, virtual universal BPb screening of 1-year-olds is inappropriate for the following reasons. Many regions have a very low prevalence of BPb >20

μg/dL, and for children with BPb levels between 10 μg/dL and 20 μg/dL, evidence is lacking of a clinically significant effect of recommended interventions to reduce BPb or of an effect if BPb is reduced. In addition, the limits of accuracy of not only capillary BPb tests, but also of venous BPb tests, can result in false labeling of children with BPb levels between 10 μg/dL and 14 μg/dL as lead-poisoned, with negative individual consequences. With data currently available, universal BPb testing and follow-up of those children with <20 μg/dL represents an unjustified burden to society and to individuals.

SELECTIVE BLOOD LEAD SCREENING

If universal BPb screening is unjustified, are there alternatives that will identify high-risk infants for whom testing is justified?

One means of identifying children in whom BPb testing might be more productive is geographic targeting. Reliable data on BPb levels in rural children are lacking, and generalizations about the prevalence of lead poisoning in urban and suburban areas are limited by differing selection criteria for testing in the available studies. Nevertheless, these studies suggest urban/suburban differences that might be useful in focusing efforts. Investigators working in urban settings reported a markedly higher percentage of children with BPb levels >10 μg/dL: 4.4% in Minneapolis/St Paul[7]; 28% in Rochester, NY[16]; 13.4% in LaCrosse, WI[9]; and 6% in San Francisco.[8] Although far fewer children were found with BPb levels >20 μg/dL—1.1% in Minneapolis/St Paul, 5% in Rochester, and 0% in San Francisco—prevalence greatly exceeded that found in suburban areas. Thus, urban areas offer a higher yield of lead-poisoned children.

Data obtained from use of the 1991 CDC-recommended questionnaire suggest another means of determining which children are candidates for selective lead screening. Questions to be asked at all health supervision visits between 6 months and 6 years pertain to the age and condition of housing in which children either live or spend much time, recent or current home renovation, association with children known to have lead poisoning, occupations or hobbies of household members, and neighborhood industries.

Five studies in this issue of *Pediatrics*,[6–9,16] evaluated the ability of the CDC questionnaire or similar questions to predict blood levels >10 μg/dL. In all five, a positive response to living in or spending much time in older houses, particularly those with peeling or chipping paint, or in houses that are being or have recently been renovated increased the likelihood of finding children with BPb levels >10 μg/dL. In one or more of the five studies, each of the questions, other than the one about living near an industry likely to produce air pollution, identified children at risk. Three of the studies reported that using all five of the CDC questions is more productive, albeit only slightly, than limiting the number of questions. Thus, although no questionnaire has a 100% positive predictive value, one that is carefully constructed can be helpful in identifying high-risk children.

A TIME FOR ACTION

Currently, nine states—including New York, California, and five in New England—have statutes requiring some or all children younger than 6 years of age to have BPb screening (C. Weng, Division of State Government Affairs, American Academy of Pediatrics, personal communication, November 1993). Of the 48 states responding to a recent Association of State and Territorial Health Officers questionnaire, only 19% did not plan to implement the CDC guidelines.[17]

The cost of universal BPb screening is unknown. Among suburban Chicago practices,[6] the case-finding cost for BPb >10 μg/dL varied from $252 to $2015. This cost was only for the BPb test; it did not include personnel time in drawing and shipping blood samples, evaluating results, and contacting families. It also did not include the cost of repeat testing, parental time and travel, counseling of parents, educational materials, and home intervention activities. These expenses occurred in children all of whom, except one, had BPb levels <20 μg/dL.

Gellert et al[11] determined that the case-finding cost for only the BPb test itself was $310 per child for those with BPb levels >10 μg/dL and $19 139 per child for those with BPb values >25 μg/dL. For testing targeted to more than 200 000 low-income California children in 1992, calculated from California state data, the estimated testing cost was greater than $8200 per child with BPb >25 μg/dL and more than $68 000 for each child with BPb >44 μg/dL.[10]

With government and industry demanding limitations on the cost of health care, expenditures for new or expanded services must be justified, and necessary services must be provided in the most cost-effective manner. For BPb levels <20 μg/dL, how much change and what effect are required for the benefit to be commensurate with the cost to both the individual family and society? Before more states mandate universal BPb screening for children, it is appropriate for the CDC to reevaluate the BPb screening recommendations. Questions about the costs and benefits of universal BPb screening, of primary prevention programs, and of secondary prevention efforts should be addressed before more inflexible laws are enacted. Information from studies reported in this issue of *Pediatrics*, as well as from other similar studies and from NHANES III, is important in helping the CDC to refine a series of questions to more accurately predict children at increased risk. Pediatricians should utilize a refined questionnaire to select at-risk children for BPb screening. In 1991, when too few children were being screened, it was appropriate for the CDC to revise BPb screening guidelines. Now, with increased knowledge about the predictive value of various questions to identify children with elevated BPb and with more information about the low prevalence of elevated BPb levels in suburban children, the CDC has an opportunity to further revise recommendations, perhaps by limiting blood screening to children at risk by history or by geographic location.

Lead is a poison, and the less of it in the bodies of growing children the better. Before recommending

intervention at BPb values <20 μg/dL, however, more data are necessary to determine the impact of BPb between 10 μg/dL and 20 μg/dL, parental response to education efforts, the effect of parental education on BPb levels <20 μg/dL, and the effect of lowered BPb, should it occur, on the individual child. Various interventions should be evaluated so that the best outcome is obtained for the investment of national and family resources.

Not only do we need to reevaluate recommendations for virtual universal BPb screening, but also recommendations for other types of universal testing of children, including newborn sickle cell testing and early infancy hearing testing.

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THE DIFFERENCE BETWEEN THE SPOKEN VS THE WRITTEN WORD

Verbatim transcripts of ordinary conversation reveals [the fractal structure of human speech]. The stops, starts, ellipses, bizarre syntax, vague references, unmotivated digressions, and sudden changes of direction are nothing like the sanitized "linear" version which usually emerges in print.

Paulos JA. *Beyond Numeracy.* New York: Vintage Books; 1992.

Submitted by Student