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Blood Lead Testing by Pediatricians: A Survey

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Blood Lead Testing by Pediatricians: A Survey

by

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Date 3/22/94

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1994

Blood Lead Testing by Pediatricians: A Survey

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February 19, 1993

Susan C. Ferguson
230 Amherst Avenue
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RE: "A Survey of Pediatricians to Determine Their Blood Lead Testing Practices and Attitudes" - Second-year Medical Student Research - UCB-UCSF Joint Medical Program, School of Public Health, SAHS

Dear Ms. Ferguson:

The project referred to above was reviewed and approved by the Committee for Protection of Human Subjects on Friday, February 19, 1993. The number of this project is 93-2-32. Please refer to this number in all future correspondence about the project.

The expiration date of this approval is February 18, 1994. Approximately six weeks before the expiration date, we will send you a continuation/renewal request form. Please fill out the form and return it to the Committee, according to the instructions.

Please note that even though the Committee has approved your project, you must bring promptly to our attention any significant changes or untoward events in your research affecting human subjects.

If you have any questions about this matter, please be in touch with the CPHS staff at 642-7461, FAX 643-6272.

Please note that CPHS is charged with implementing Federal regulations and University policies concerning research on human subjects. Those rules impose some unavoidable burdens on all university personnel who conduct such research, but the Committee is concerned that no additional and/or unnecessary burdens be added. Accordingly, if your experience suggests ways in which CPHS might reduce the burdens without violating the letter or spirit of our charge, we would be grateful for any written suggestions you care to make.

Sincerely,

Austin Ranney

Austin Ranney
Professor of Political Science
Chair, CPHS

cc: Professor Jeff Gould
Graduate Assistant

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Epigraph

The toxic nature of lead has been known for millennia. As evidence of this I present the following verse by Nikander, a Greek poet and physician of the second century B.C. In the poem Nikander tells of the adverse consequences of working with "cerussa" which is lead carbonate (Major '39).

> The harmful cerussa, that most noxious thing
> Which foams like the milk in the earliest spring
> With rough force it falls and the pail beneath
> fills
> This fluid astringes and causes grave ills.
> The mouth it inflames and makes cold from within
> The gums, dry and wrinkled, are parch'd like the
> skin
> The rough tongue feels harsher, the neck muscles
> grip
> He soon cannot swallow, foam runs from his lip
> A feeble cough tries, it in vain to expel
> He belches so much, and his belly does swell
> His sluggish eyes sway, then he totters to bed
> Phantastic forms flit now in front of his eyes
> While deep from his breast there soon issue sad
> cries
> Meanwhile there comes a stuporous chill
> His feeble limbs droop and all motion is still
> His strength is now spent and unless one soon aids
> The sick man descends to the Stygian shades.

Preface

This thesis was undertaken to answer two questions: 1) Are the federal recommendations for universal blood lead testing of children known by primary care pediatricians?, and 2) Are the recommendations being followed? The thesis includes an introduction followed by three manuscripts intended for future publication. The introduction comprises the first chapter. In it, the issues that make childhood lead poisoning so important are discussed. The prevalence of lead exposure, how children are exposed to it, and how lead damages the brain are all explained. The introduction also includes a brief history of policy development concerning this problem. The second chapter, entitled "Attaining a High Response Rate in a Mailed Survey of Physicians", is a manuscript for a paper which describes the techniques used to attain an 86% response rate in a self-administered mailed survey of physicians. The survey addressed the specific blood lead testing practices of local pediatricians. This portion of the thesis is organized as a "brief report" intended for publication in the American Journal of Public Health. The third chapter is entitled "Blood Lead Testing by Pediatricians: A Survey." This chapter presents the findings of the survey described in the second chapter. This portion of the thesis is also intended for the American Journal of Public Health but as a "full report." In the fourth chapter conclusions and editorial

comments about the findings of the survey are presented. This portion of the the thesis is intended for the California Pediatrician, a publication for members of the American Academy of Pediatrics who practice in California.

Because each of the last three chapters is a manuscript that can stand alone, some information is repeated.

Acknowledgements

The people I wish to thank fall into three categories: those who inspired this thesis, those who kept me going intellectually with their thinking about it, and those who kept me going with financial and moral support.

The idea for this thesis came from Dr. Michael DeBaun, a fellow researcher who I had the pleasure to meet over the phone a year ago. My work on lead in general actually preceded the conversation with DeBaun by several years. I worked on health policy development to re-institute the California Childhood Lead Poisoning Prevention Program while living in the capital of California, Sacramento. In this capacity several people then working in the State Department of Health Services were inspirational to me. Most notably, Drs. Susan Cummins and Lynn Goldman were most supportive and helpful from the start.

All members of my thesis committee helped tremendously with their encouragement and feedback while this thesis was being developed. Thank you Drs. Gould, Blum, Newacheck and Weisner. In addition, Drs. Marian Diamond and Alan Steinbach gave me important guidance during development of the introductory material on neurophysiology and laboratory analysis of blood lead samples. Dr. Selma Monsky assisted with valuable guidance during the development of the questionnaire and survey plan. Dr. Seth Roberts helped with

the initial analysis of the data generated by the survey, and Ms. Bette Anton, librarian for the Health Sciences Information Service, provided invaluable help throughout the development of the thesis. Bette's database sleuthing helped turn up such marvelous titles as "Lead Poisoning and the Fall of Rome." I am also greatly indebted to Ms. Maggie Hall for her patient assistance in editing the entire manuscript twice.

Dr. Tracy Lieu helped immeasurably during the conception of this thesis, in gaining funding, most notably in the organization of the data generated by the survey, and in the statistical analysis of the findings. Without Tracy's intellectual help and moral support, this thesis would not have been possible.

This thesis was funded through a variety of sources. Partial funding was granted from the NIH via the UCSF Summer Research Program, the Robert Wood Johnson Clinical Scholars Program, and the UC Berkeley-UCSF Joint Medical Program. I am grateful for these resources.

Moral support was most lovingly provided by my husband Ken Finney, and my parents Natalie and John Ferguson. Our daughter, Annelise Finney was born during the writing of the thesis, and she brought feelings of love into our lives beyond anything we could have imagined.

Chapter 1.

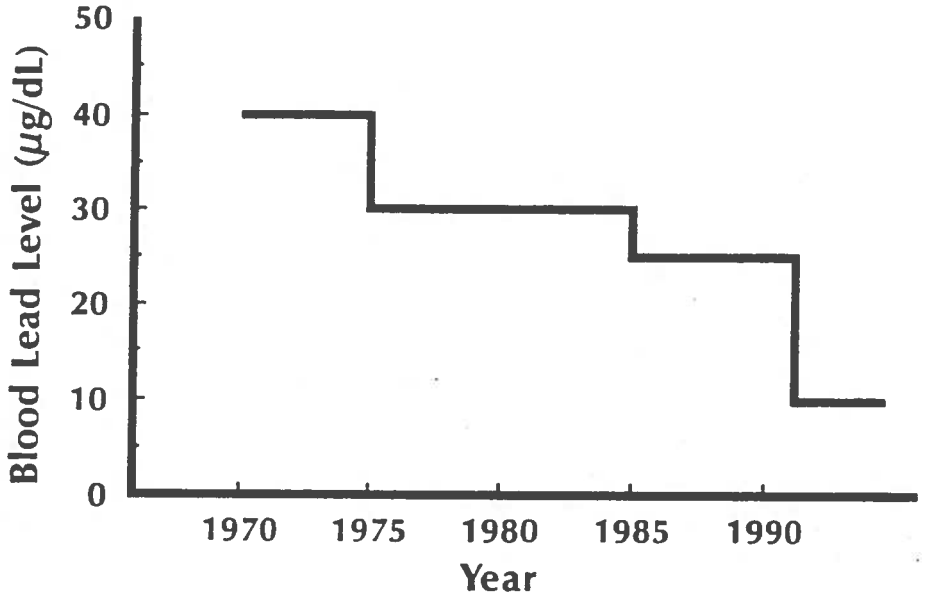
Introduction

In October of 1991, the Centers for Disease Control and Prevention (CDC) proclaimed lead poisoning the most significant pediatric environmental issue facing the nation (CDC 1991). Largely through ingestion of deteriorating paint, children were found to be at special risk because lead is a neurotoxin that harms the developing brain.

Though earlier CDC statements on the lead poisoning problem had listed 40, then 30, then 25 ug/dcl as the lowest level at which deficits in cognitive functioning occurred, the CDC's most recent statement lists the level at 10ug/dcl, based on more recent research (CDC '91). This proclamation then vastly increased the number of children considered lead poisoned to roughly 4 million nationwide. The number of children with lead poisoning reported to the CDC at the old level of 25 ug/dcl in 1988 (11,793) was, even at that time, greater than the reported number of children with measles, mumps, and pertussis combined, all infections for which there are now national vaccination programs (CDC '91). However, perhaps because the effects of lead poisoning are not so immediately dramatic as those of infectious disease this ailment has typically not been given so much attention.

Figure 1.

Blood lead levels considered elevated by the Centers for Disease Control and the Public Health Service



(CDC '91)

Because such a large number of children were found to have been exposed to lead and because the CDC found no fail-safe way to locate those children who have been exposed, the agency recommended that all children be systematically tested for lead poisoning at the age of 12 months (CDC 1991).

In the next few pages, I will explain how lead has been used historically and how it is used in our society today, I will next tell how children, especially toddlers, are exposed. I will explain how lead poisons the developing brain, and I will tell how children's blood lead levels are tested. Last I will discuss the history of policy development concerning lead in California.

Historical exposure to lead

Lead has been ubiquitous in our societies since the dawn of recorded history. Because of its excellent ability to hold pigment and because it is malleable yet durable, the Ancient Egyptians used lead to make jewelry and cosmetics (Gilfillian '65). The Romans used it to make tableware, in wine processing and storage, and in their famous aqueducts and plumbing systems (Gilfillian '65 and Jaroff '91). Indeed, it is this latter use that some think liberated enough lead into the Roman drinking water supply to contribute to the downfall of that civilization (Gilfillian '91).

During the Industrial Revolution, lead became widely dispersed in the human environment. Paint manufacturers used lead and other heavy metals for their ability to hold color as the Egyptians did and also to yield a smooth finish (Becker '85). Besides the use in paint, lead was later used in battery manufacturing and as an additive to automobile gasoline. Battery smelter operations caused a concentration of lead in the soils around them, and they, along with construction sites, continue to pose a threat to people working in those areas. The lead in these environments not only can reach harmful exposure levels for the adult workers themselves, but lead dust brought home on work clothing can also introduce toxic levels to family members. (Landrigan '90, CDHS '91,).

The EPA officially recognized the harmful effects of lead as an additive to gasoline in 1975. Though the EPA lowered the allowable level of lead in gasoline in 1982, and again in 1986 finally to a level of 1 gram per gallon, high levels of lead in soils still exist especially near heavily traveled freeways and along roadsides where cars once spewed leaded automobile exhaust every day (Mushak '90).

Alongside these industrial uses of lead there developed a string of uses in folk medicine. Because of California's large ethnically diverse population, these uses have been brought to the attention of local and state health care officials. Some Hispanic groups have been found to use an alleged remedy for stomach ailments called "Azarcon" or "Greta," that has been found to contain up to 86% lead tetroxide (Schlag '92). Similarly, some Southeast Asian groups have been found to use a substance called "Pay-loo-ah" which is also largely comprised of lead. These uses came to the attention of health care officials when several children were found to be severely poisoned with lead following treatment with these so-called remedies. (CDHS '90). The California State Department of Health Services (CDHS) has conducted active public health education campaigns to reduce the exposure from folk remedies (Schlag '92). Furthermore, pottery and dish ware decorated with leaded paint, eating utensils made of alloys containing lead, and even leaded crystal food and beverage containers

have been found to cause dangerous exposures because lead leaches from the containers and utensils into food. (Appel '92, CDC '91, Schlag '92).

Water contamination from lead pipes or lead solder used to join pipes has also been found to pose a long-term significant risk, especially when the water supply has a high acidity (Rogers '91). Such exposures are especially significant for pregnant women and infants because these groups appear to absorb lead more readily (CDC '91, Silbergeld '91).

Current sources of lead exposure

Infants are exposed to lead primarily through the dust of chalking and peeling paint (CDC '91). Though lead was largely removed from household paint in the 1950's and banned in 1978, many existing houses were, of course, built and painted before those times. In addition, even those built after the 1950's may have been covered with paint that was manufactured before those dates (Florini '93). Other buildings painted after 1978 may have deteriorating paint that may expose surfaces painted earlier (CDC '91, MMR '88, and Rogers '91). As painted surfaces deteriorate, the paint peels, flakes, and "chalks," releasing the lead it contains into the environment in the form of chips and fine dust. In 1980, in Alameda County, for example, an estimated 81,000 children lived in houses and apartments built before 1978 (Rogers '91). This figure is based on 1980 census

information and how applicable it is to 1994 is unclear.

Exposure in children

Young children are exposed to the dust of lead based paint through normal hand-to-mouth behavior (CDC '91). Though exposures from folk remedies, from dust brought home on parents' work clothes, and from other sources are significant, the major and most significant route of children's exposure to lead is from deteriorating paint. As an infant begins to explore the environment, normal (and practically incessant) mouthing behavior occurs. If household surfaces and toys are covered with a fine dust from lead-based paint or if paint chips are available to eat or chew, dangerous levels of lead can be ingested in a very short time (Kizer '90). When considering if a child is exposed to deteriorating paint, one must review, of course, all of the environments a child is exposed to: not only the home and surrounding areas, but also play areas and equipment, and other sites the child may frequent such as a day-care center or pre-school. Restoration and remodeling of old homes has been found to be an especially dangerous source of lead exposure (CDC '91).

Hand-to-mouth behavior is the most significant way children are exposed to lead. Children between 6-18 months of age are at highest risk, because it is during this time period that three major developmental events are occurring simultaneously. First is almost incessant mouthing

behavior. After observing a child this age, one might conclude the child thinks, "If it can't go in my mouth, it doesn't exist." It seems everything possible goes in the mouth, or at least is mouthed to explore the object's size, texture, temperature and taste. Second, the child is beginning to be mobile by crawling, creeping, rolling or walking, thus vastly increasing the size of the environment he contacts. Third, the brain is undergoing tremendous development, making the brain especially vulnerable to the effects of lead as explained below.

Lead as a neurotoxin

Lead harms the brain by interfering with normal neurological development. In the following paragraphs I will discuss some basics of brain development. I will then discuss how lead affects this qualitatively. I will then discuss some of the subcellular details.

The diagram below outlines the development of neurons in the brain during prenatal and early postnatal life.

Figure 2.

Prenatal life	Birth	8 months	36 months
<----------X---------->			
Neurons formed about 50% die	Synaptogenesis more than pruning	Pruning about equal to synaptogenesis. Plasticity maintained throughout life.	
BRAIN BLOOM	IMPRINTING AND PRUNING	CONTINUING PLASTICITY MATURING AND LEARNING	

(Based on Kandel and Schwartz'91, Goldstein '90, and Diamond '92)

Prenatal life is characterized by the formation of many more neurons than appear needed in post-natal life. No one knows the purpose of the formation of so many neurons when so many die prenatally. Perhaps the purpose is merely to establish an abundance of options for later neuron selection -- setting the stage for a "survival of the fittest" neurons. Several authors have invoked the notion of Darwinian selection when discussing the development of the brain (Goldstein '90, Kandel and Schwartz '91).

Selection of the neurons that survive does have some fairly sound explanations (Kandel and Schwartz '91). In general, the pruning of neurons has to do with the "Use it

or lose it" rule. If a neuron is not involved in the transmission of an impulse, after a while, it will die. Kandel and Schwartz explain further that the establishment and maintenance of specific synapses between neurons are also affected by this process. During development, the brain is constantly trying out impulse pathways in response to environmental stimuli. Those synaptic pathways that are used the most, that is, those determined to be not only the most useful but also the most efficient, are the ones that are maintained and strengthened both on a biochemical and on a physical level (Kandel and Schwartz '91). The plasticity of this process appears to be greatest in early postnatal life; however, a slower plasticity is maintained throughout life (Diamond '92).

The precision with which a brain can respond to both the internal and external environments by forming the most efficient synaptic pathways has to do not only with basic adaptation but is currently thought to be the essence of learning and memory (Kandel and Schwartz '91). Daube '(86) underscores the importance of this basic mechanism by stating that "... Memory is the substrate for all higher mental functions ... [It] is the prerequisite for learning and adaptive behavior."

The area of the brain called the hippocampus is currently thought to be the site of both short-term memory storage and the site of the conversion of short-term memory

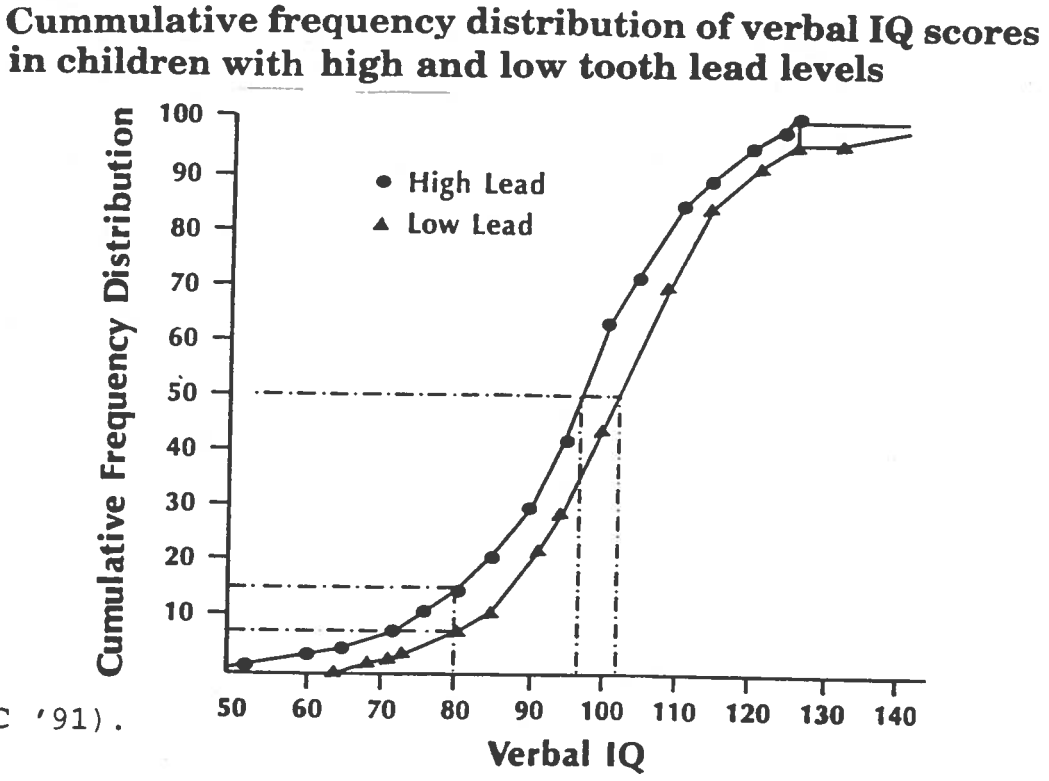
to long-tern memory (Campbell '81, Kandel and Schwartz '91). Furthermore, this area of the brain is known to control seizures. The hippocampus includes granule cells with short axons and a high concentration of Golgi II cells, both of which have the capacity to divide. Whether this capacity to divide is directly related to memory or seizure control is not known. However, this capacity may be related to the tendency of this area of the brain to accumulate lead and to be particularly sensitive to lead exposure (Diamond '92).

Lead is thought to be toxic because it is mistaken for calcium which is required for the transmission of impulses from one neuron to the next. In vitro experiments have demonstrated that Pb2+ acts both as a Ca2+ agonist and as a Ca2+ antagonist, generally scrambling the neuron's range of responses to synaptic signals. Instead of developing strictly according to the "Use it or lose it" rule described above, some neurons exposed to lead fire when they are not used, and some do not fire when there are attempts to use them. Because of this, the "pruning" away of neurons is not based on the actual need to use or not use certain neuronal pathways. Thus, the developing brain must use less than the most efficient nerve pathways to get its work done. The result is an inefficient brain with measurable cognitive deficits, including a suboptimal I.Q. (Kandel and Schwartz '91, Diamond '92).

Various researchers (Bellinger '91, Goldstein '90,

Landrigan '90, Needleman '79, '90) have found that prolonged exposure to lead can result in serious neurological defects. These defects include reduced I.Q., reading disabilities, attention deficits, and hearing loss (Summit '90, CDHS '90, Bellinger '91). The reduction of I.Q. has been estimated at 4-7 points in any individual child at a 10 ug/dcl level (Needleman '90). Whereas a reduction of up to six points in any individual may go unnoticed, the effect on an entire population can be devastating. A reduction of six points in a population of 270 studied by Needleman et al. ('79) resulted in a complete loss of individuals with I.Q.s above 125, and a four-fold increase in individuals with I.Q.s below 80 (mentally retarded), for example. The chart below shows this effect.

Figure 3.



(CDC '91).

Furthermore, a blood lead level of 10 ug/dcl has been shown to increase high-school drop-out rates seven times, and to increase significant reading disabilities six-fold even with control of many covariates including poverty, low maternal education, and low maternal I.Q. (Needleman '90). Some researchers argue that lead exposure may increase criminality and related costs to society (Needleman '90).

It must be noted that the data showing harm caused by low levels of lead have been contested. These data were first compiled by pediatrician-epidemiologist Dr. Herbert Needleman who studied populations of school children in Boston, Mass. ('79, '90). In recent years, several journals have published the counter-arguments of Dr. Edgar Schoen, the former Chief of Pediatrics at the Kaiser Permanente Medical Center in Oakland ('92,'93). Schoen contends that Needleman's studies demonstrating I.Q. loss and other cognitive deficits in children exposed to lead were not adequately controlled for socioeconomic status and other known contributors to low I.Q.(Schoen '92,'93). Schoen further contends that the lead poisoning issue has been disappearing as various sources of lead, such as gasoline and paint, now have reduced or eliminated lead content (Schoen '92,'93). Schoen believes other pediatric issues are much more important than lead. He believes that a child's risk for lead poisoning can be determined through use of a screening questionnaire such as that which Kaiser

Oakland now uses.

Schoen's concerns have been carefully answered in the published literature by epidemiologist-pediatricians Dr. Lynn Goldman and Dr. Susan Cummins who have shown that the studies illustrating the consequences of lead exposure were well controlled for socioeconomic status and other possible confounders (Goldman '93, Goldman and Cummins '93). Furthermore, Goldman and Cummins have shown that authors affiliated with a variety of institutions studying populations in a range of areas have published, before and since the CDC's 1991 statement, a multiplicity of studies that substantiate Needleman's original findings. Studies by Bellinger ('92), Baghurst ('92), Dietrich ('93), Florini ('93), Mushak ('90), and Sciarrillo ('92) have all substantiated Needleman's findings that lowered I.Q. can be related to measurable low levels of blood lead.

Blood lead testing techniques

Venipuncture is required to determine the blood lead level in a child. The CDC's 1991 statement on lead mentions that venipuncture is currently the only reliable way to sample children's blood for lead. An older technique was to sample blood and then test the free erythrocyte protoporphyrin (FEP) content as a surrogate for lead (CDC '91). This technique turned out to be not only invalid for blood levels below 25 ug/dcl but it also produced many false positives because iron-deficient anemia also elevates the

FEP level.

Actually blood can be both sampled and tested for blood lead in a variety of ways. Without going into the details of each technique, I will simply note that both the sensitivity and specificity of the tests are complicated by the various sampling techniques, and by the need for and variability of staff to perform the tests and analyze the results (Gunter '92).

Currently much activity is underway to develop more and more sensitive and accurate lab techniques and safer and more accurate field collection of finger-stick samples. The sensitivity of the analysis performed in the lab is also being improved. Recent advances in technology for testing blood glucose levels in diabetics is being explored for possible use in blood lead testing (Gunter '92). The goal, of course, is to develop portable, rugged blood lead testing machines that can be used in the field.

Similarly, more accurate devices for finger-stick sampling have been developed with glucose monitoring in mind, and these devices are also currently believed to be appropriate for improving the uniformity of mass finger-stick sampling (Gunter '92). Several documents have been written instructing health care personnel in how to get the most accurate finger-stick sample, including instructions on cleaning and preparing the hand to minimize environmental contamination (Lyngbye '90, CDC '91). Stanton ('92)

reported contamination rates as low as 1% using such techniques. Parsons reported that the contamination rate depends on the training and carefulness of the sample collector ('92).

To date, all laboratory workers with whom I discussed these issues still rely on a venous sample to confirm a diagnosis. The current standard of care advocated by the CDC is that all blood lead levels based on finger-stick samples must be considered presumptive and all must be confirmed by a venous sample before a diagnosis can be made (CDC '91, Parsons, Stanton, and Gunter '92). All also agree, however, that finger-stick sampling is appropriate for the large-scale screening currently required in some, but not all, states (Goldman '92).

Programs for lead testing of large populations of children are just beginning to get rolling. Technologists are sharpening their lab techniques; and health care officials are re-defining the techniques they need to use for better sampling. All of this activity will increase as awareness grows of the necessity to test all children for lead poisoning.

History of policy development regarding lead

Over the past five years various government entities and medical organizations have developed policies and recommendations in response to the need to test children for blood lead. This activity has been especially heavy in

California's Alameda and San Francisco Counties.

As early as 1977, lead was recognized as a serious public health problem in California, as evidenced by the passage of specific provisions in the State Budget Act of 1977-78 directing the California Department of Health Services (CDHS) to investigate the extent and nature of the problem posed by environmental lead (Harvey '79). Despite this call to action, the State Childhood Lead Poisoning Prevention Program went unfunded and continued to lack funding into the 1984-1985 fiscal year.

In 1985, largely because of improved technology for testing and laboratory analysis, the CDC lowered the level of blood lead known to be dangerous from 35 to 25 ug/dcl. In response to this action in 1986, environmental, disability rights, and medical groups joined forces and got the California Legislature to pass AB 2977 (Connelly, Chapter 481, Statutes of 1986) which directed the Department of Health Services to re-create the Childhood Lead Poisoning Prevention Program. The charge to CDHS this time was to screen children in three high-risk areas for elevated blood lead levels and to make specific abatement recommendations to the Legislature (CDHS '90).

The Department's study focused on the Compton/Wilmington area of greater Los Angeles, south Sacramento, and the Fruitvale area of Oakland. The findings were quite revealing. In the Oakland area, 67% of the

children tested were found to have blood lead levels above 10 ug/dcl. The Department's report further states that approximately 20% of the children tested in the area had blood lead levels high enough to require immediate medical intervention (20 ug/dcl). Thirty-seven percent of the homes tested had interior lead paint which contained enough lead to require clean-up under the Department of Housing and Urban Development guidelines for federal housing and soil (5,000 ppm), and almost half of the houses tested contained enough lead to qualify the properties as hazardous waste sites (CDHS '90).

Shortly after this report was written, the CDC officially lowered the level at which lead is considered hazardous to 10 ug/dcl (CDC '91).

Naturally, these findings alarmed the citizens of Oakland. When a group took their children to be tested for lead poisoning, employees of the state's Child Health and Disability Prevention Program (CHDP) refused to perform the tests or arrange to have them done (Portillo '91). This refusal resulted in the filing of a lawsuit in December 1990 by citizens of Oakland, the Alameda County Legal Aid Service, the Natural Resources Defense Fund, the NAACP, and others against the Director of the California Department of Health Services (Portillo '91, Weidess '91). The suit was settled in October of 1991 with the State agreeing to provide lead screening under CHDP (Portillo '91).

Concurrent to the lawsuit, environmental, medical, and disability rights groups again joined forces in Sacramento in support of three pieces of legislation to improve lead screening and abatement services in California. All three bills were passed and signed into law. AB 2038 (Connelly) establishes a standard of care stating that all children must be regularly evaluated for risk of lead poisoning. The bill further mandates an excise tax on industries that use lead, the revenues from which will fund lead poisoning testing, case management, and abatement throughout the state. Another piece of legislation AB 1979 (Lee) requires health insurance policies and health maintenance organizations (one of which is Oakland's prominent Kaiser Permanente) to cover the costs of blood lead tests for children. The third piece of legislation, SB 240 (Torres) establishes a comprehensive program in the CDHS for prevention of occupational lead exposures (Dresslar '91). Interestingly enough, the Governor decided to give his approval for these bills in a public fashion, releasing news of his signing on the day the lawsuit was settled. Such political awareness bodes well at least for the immediate future of lead intervention programs. The lawsuit seems to have attracted the Governor's attention.

Alongside this saga of lead policy in the State, policy development was also occurring on the national level. Simultaneous to improvements in sampling and laboratory

analysis of lead in blood, publications were mounting of scientific studies showing how harmful lead can be at lower and lower levels. In 1990 and 1991 the U.S. Congress held two hearings specifically on lead poisoning. Officials at the CDC were studying both the scientific and government reports, and, as mentioned above, in October of 1991 (a fateful month for lead) this agency issued its statement recommending universal blood lead testing of children. In the summer of 1993, the American Academy of Pediatrics (AAP) issued its policy on lead testing which closely follows the CDC's recommendations (AAP '93).

Pediatrician response to policy development regarding lead

From the time the lead-testing policies and recommendations of 1991 were enacted until February 1994, no one had published information on how the policies were playing among pediatricians practicing on the front lines. One report published in February of 1994 told of a survey conducted around the time the recommendations were published. This report showed that only 12% of pediatricians practicing in Virginia were testing all patients for blood lead (Bar-on '94).

Further anecdotal information has held that few pediatricians in California are following the federal recommendations. Only recently has the CDHS compiled a system for reporting the number of lead tests ordered and the number of tests with results over 25 ug/dcl (CDHS '92).

The number of tests ordered appears to be far below that which would constitute universal testing (CDHS '92).

It was my belief that policy makers at state and federal levels, as well as those involved in medical organizations such as the American Academy of Pediatrics, would benefit from a survey that could show the response in the field to the lead testing recommendations put forth by state and federal entities. Unlike Bar-on ('94) my approach involved a look at compliance with the recommendations two years after their publication. In the fall of 1992, I decided to design and conduct a survey of pediatricians practicing in Alameda and San Francisco Counties to determine the extent of lead testing being done. The design pretest and piloting of the survey took six months (fall 1992 and spring 1993); I conducted the survey over the late spring and summer of 1993 and analyzed the data in the fall of 1993. Because no one else has compiled this type of information for California, policy makers remain in the dark as to the effect of their recommendations so far. It is hoped that the following information will serve to make policies in the future more effective in the field.

* * * * *

The next chapter addresses the study design and methods used to survey a population of pediatricians concerning their blood lead testing practices.

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Chapter 2.

Attaining a High Response Rate in a Mailed Survey of Physicians

Abstract

Objectives:

Numerous researchers have found it difficult to attain a high response rate from physicians by using an easily administered survey. We conducted a mailed survey of pediatricians regarding their blood lead testing practices. The survey was conducted in part in order to see if a significant response rate could be achieved using this least invasive technique.

Methods:

A written questionnaire was mailed to a sample of all pediatricians in practice in two specific counties in California. Pediatricians were considered eligible if they were not retired, if they provided primary care to children, and if they provided care to children residing in the study area.

Results:

Of the 180 eligible pediatricians, 155 (86%) responded.

Conclusion:

This survey demonstrates that a significant response rate can be attained in a mailed survey of physicians. The specific techniques described below can help other researchers to seek out and gain valuable information about physician practice and attitudes. Researchers who compile

feedback from medical practitioners easily and cheaply can provide a valuable service to medical groups and policy makers as health care reform initiatives are enacted.

Background

Because physicians are central figures in health care delivery in this country, many researchers have been interested in compiling information regarding physician practice trends and physician attitudes about various aspects of medical care. Although the use of surveys has been a popular method for gathering this information, many researchers have had trouble in their attempts to generate a response rate that can yield significant data. Published response rates range from 56% to 83% as shown in Table 1. Some researchers resort to huge sample sizes (Boice 1992) to ensure statistical power despite the bias that might be generated by a low response rate.

To boost response rate some researchers resort to particularly aggressive techniques, such as certified mail, which requires the respondent to sign for the questionnaire in person either at the post office or at home (Rimm '90), or expensive techniques such as contacting the respondent by telephone (Boice '92, Edwards '89). This later technique is particularly expensive in surveys of physicians not only because of the cost of telephoning in what may be a large geographic area but also because many physicians are so difficult to reach that many calls are needed to make contact.

Table 1.

Mailed Surveys of Health Care Professionals

	Methods			Response	
Author	Subjects	Materials	Mailings and Follow-up	n	%
Boice 1992	Radiologic Technologists	16p questionnaire Non-respondents administered abbreviated questionnaire	One mailing telephone follow-up	104,000	79%
Edwards 1989	Chairs of pediatric teaching programs	15 multiple-choice or short-answer questions	Contact by telephone followed by two mailings	22	78%
Hensrud 1992	Physicians	Questionnaire (length not given)	Three mailings Telephone contact of non-respondents after second mailing	393	83%
Rimm 1990	Male health professionals	Four-page questionnaire Fourth and fifth mailing one-page	Three mailings by bulk rate plus two by certified mail	41,079	79.5%
Slagle 1992	Neonatal intensive care nurseries	38 multiple-choice questions	Three mailings	305	69%
Bar-on 1994	Pediatricians	22-item questionnaire	Three mailings	661	56%
Ferguson 1994 (this thesis)	Pediatricians	14-item questionnaire	Three mailings	155	86%

Many researchers have published information about specific techniques to increase response rates in mailed surveys (Abramson '90, Cartwright '83, Spry '89, Rimm '90, Boice '92, Hemmelgarn '91, Sudman '83); a few have addressed techniques to use specifically for physicians (Glotzer '92, Hensrud '92, Aday '89). These techniques are presented in Table 4 on page 37 below.

In the spring and summer of 1993, a sample of pediatricians practicing in the San Francisco Bay Area region of California was contacted exclusively by mail as part of a survey. The subject of the survey was blood lead testing by pediatricians. The survey was conducted in part to determine if a significant response rate could be attained using this least invasive survey approach, given specific techniques.

Methods

Subjects: A sample of pediatricians practicing in Alameda and San Francisco Counties was compiled through cross-referencing two mailing lists: the American Academy of Pediatrics (AAP) membership list for the two counties, and the California Medical Association's (CMA) record of all pediatricians listed with an Alameda or San Francisco County zip code who were also listed as primary care practitioners (n=244). The CMA compiles its mailing list and specialty information from a combination of sources including the organization's own member database, the American Medical

Association's member database, and information from the California Board of Medical Quality Assurance (the State medical licensing agency) (Williams '94). To be included in the sample, pediatricians had to appear both on the Academy member mailing list and on the CMA list.

Questionnaire: Each of the pediatricians was sent a fourteen-item questionnaire which had been designed and pretested on a group of 50 medical students and private practitioners, then pilot-tested on a convenience sample of 10 pediatricians to ensure clarity of interpretation and ease of completion. The final questionnaire was printed in book format on one sheet of yellow 11" x 17" paper folded in half. To maximize readability, Times Roman 12 point typeface was used. Only the title of the survey, the name and address of the researcher, and a disqualifying question appeared on the front of the questionnaire. There was only one skip question at the beginning of the questionnaire, and only one open-ended question at the end. All other questions were multiple-choice.

The most interesting questions were placed at the start of the questionnaire; the demographic questions at the end.

Mailings: The first mailing was sent in April of 1993. Two more mailings to non-respondents followed during the next eight weeks. All three mailings were sent first-class and timed to arrive in late spring, the least busy time of year for local pediatricians, as it is at the end of the flu and

allergy seasons but before school physicals.

The outer envelope for the first mailing was affixed with a first-class stamp, it had a printed university return address, and it was stamped with the researcher's name above the return address. The respondent's address was printed on a label. The mailing included the questionnaire printed on yellow paper, a personalized dated and signed cover letter from the chairman of the local chapter of the AAP printed on original AAP letterhead, a stamped return yellow envelope with the return address printed on it, and a stamped return-addressed orange post card for the respondent to use if a report of study results was desired.

For each mailing, respondents were asked to respond within 10 days. If no response was received after 21 days, the respondent was sent the next mailing.

The second mailing contained the same materials as the first, except that a new cover letter was enclosed which acknowledged that the respondent had been contacted once before and was politely being requested once again to respond. The importance of the individual's response was emphasized.

Before the third mailing, all addresses were verified using telephone general information, by contacting local hospitals, and by consulting university listings.

The third mailing contained the same materials as the second mailing, including the same cover letter. However,

the date on the cover letter was updated by hand, and a personalized, hand-written note from the researcher was written at the top of the cover letter. This note stated that only a few more respondents were needed to make the study highly significant and it politely, once again, requested a response. The outer envelope of the third mailing was hand-addressed.

Analysis: Data from the returned questionnaires was entered and organized using a D-BASE IV program. Data analysis was conducted using SAS.

Results: Of the 244 pediatricians on the mailing list, 219 responded, and 25 did not, yielding a 90% crude response rate. Of the 219 respondents a total of 64 were deemed ineligible either because they were retired (n=23), because they did not practice in the study area (n=6), or because they did not provide primary care to children (n=35). The final study group numbered 180.

A total of 100 pediatricians eligible for the study responded to the first mailing (56% of the study group), 36 to the second mailing (representing an additional 20%), and 19 to the third mailing (representing an additional 11%). There were 25 non-respondents representing 10% of the final study group.

Table 2 shows the demographic characteristics of the four respondent groups.

Table 2.

Demographic Characteristics of Respondents By Timing of Response

	A		B		C		D	
	n	%	n	%	n	%	n	%
Gender								
F:M	42:58		16:20		7:12		12:13	
(% female)		42%		44%		37%		48%
Race								
white:non-white	82:18		27:8		14:5		(unknown)	
% white		82%		77%		74%		
Date Residency completed								
Since 1988	30	30%	7	19%	5	26%	8	35%
1983-1987	14	14%	6	17%	2	11%	3	13%
1978-1982	10	10%	2	6%	3	16%	4	17%
Before 1978	46	46%	21	58%	9	47%	8	35%
Practice setting								
Private practice	60	61%	25	69%	14	74%	(unknown)	
HMO	21	21%	4	11%	3	16%	(unknown)	
Clinic / academia	18	18%	7	19%	2	11%	(unknown)	

Caption Those who responded after the first mailing are designated 'A' those who responded after the second mailing 'B', those who responded after the third mailing 'C'; and non-respondents 'D'. When the variables of gender, race, date residency was completed, and practice setting were considered, no significant difference was found between the groups responding to the various mailings.

Table 3 below presents the demographic features of the respondents overall compared to non-respondents.

Table 3.

Demographic Characteristics of Respondents Versus Non-Respondents

	Respondents		Non-respondents	
	n	%	n	%
Gender F:M (% female)	65:90	42%	12:13	48%
Date Residency Completed *				
Since 1988	42	27%	8	35%
1983-1987	22	14%	3	13%
1978-1982	15	10%	4	17%
Before 1978	76	49%	8	35%

* No information on residency dates could be found for two of the non-respondents

Caption When the variables of gender and date residency was completed were considered, no significant difference was found between respondents and non-respondents. There was not enough information on the non-respondents to test any other variables.

Discussion

Techniques for elevating response rate

Mixed strategies

Table 1 compares aspects of this study to those done by others using health professionals as subjects. The table shows that the three groups that attained the highest response rates (79% by Boice, 79.5% by Rimm, and 83% by

Hensrud) used mixed strategies: either a combination of mailings and phone contact or bulk mail followed by certified mail. In this study, the temptation to contact physicians directly by phone or to use certified mail was resisted as too labor-intensive, too expensive, and too invasive. The pilot study revealed that many phone calls were needed to make contact with some physicians. In a few cases, attempted contact by phone was never successful, so the method was abandoned. In this study the telephone was used only to verify the mailing address of all non-respondents after the second mailing. Though Table 1 would lead the reader to believe phone contact or some other aggressive approach was necessary to attain a high response rate, such approaches were not used in this study and a high response rate (86%) was attained nonetheless.

Truncated questionnaires

Table 1 also shows that some research groups (Boice '92 and Rimm '90) had to resort to using a truncated questionnaire for either the last mailing or a final attempt at contact by telephone. In this study, such an approach was resisted because a more complete dataset was desired. The questionnaire was carefully designed to be short in the first place. The pretest revealed that it took approximately 5 minutes to complete the questionnaire, and this was stated in the questionnaire cover letter.

Small sample size

Table 1 also shows that three of the published surveys included much larger populations than did this study (Bar-on '94, Boice '92, and Rimm '90). This size allowed the researchers to achieve ample statistical power despite any bias that could be generated by a lower response rate. In this study, a smaller sample was used with the understanding that intensive follow-up would be necessary. The higher response rate in this study helped minimize potential bias.

Questionnaire length

None of the published reports of the surveys listed in Table 1 defined all aspects of the mailings in detail. Though most stated the number of questions in the questionnaire and some described page length, only one report (Slagle '92) gave both. (Indeed, the publication of this study includes the entire questionnaire.) Based only on reported question number and page length, it appears this study had a length that was slightly shorter than most. This may have enhanced the response rate as Aday ('89) Cartwright ('83) and others have suggested.

Unfortunately, the published reports listed in Table 1 do not indicate many of the details of the questionnaires or of the mailings that would be interesting to compare, so it is impossible to judge exactly which, if any, of the specific techniques were most effective in boosting the response rate in this study.

Specific techniques used in this study

In this study, both published and unpublished techniques were used, as shown in Table 4 below.

Table 4.

Published and Unpublished Techniques Used to Boost Response in This Study

Published *	Unpublished
Materials, first mailing	
• Colored materials	• Times Roman 12-point typeface to increase readability
• First-class mail	
• Stamped outer envelope	
• Letter of endorsement dated and personalized	• Letter and questionnaire folded so personalized salutation is seen as soon as envelope is opened
• Stamped, addressed return envelope enclosed	• University return address imprinted on outer envelope
• Stamped postcard enclosed for requesting report of study findings	• Mailing timed to arrive during pediatrics "low season"
Second mailing	
• Second letter, again dated and personalized	• Personalized handwritten note added to top of cover letter for some respondents
• Second mailing sent only to non-respondents	
Third mailing	
• Handwritten address on outer envelope	• Personalized handwritten note added to top of cover letter for all respondents
	• All addresses verified by telephone

* Aday ('89), Cartwright ('83), Sudman ('83), Spry ('89), Rimm ('90), Glotzer ('92), Edwards ('91).

Many techniques not found in the published literature were used in this survey; these are described generally in the table above. Specifically, consideration of the pediatricians' time constraints was given. For example, the survey was mailed in late spring, the pediatrics "low

season." This factor may have enhanced the response rate.

Also, personalized hand-written appeals were added to the top of some cover letters in the second mailing, and all cover letters in the third. This point has not been discussed in the literature, and this study was not designed to study the effect of this approach specifically. But it is believed that this personal appeal may have encouraged some questionnaire recipients to respond.

The addresses of all non-respondents were verified by telephone after the second mailing. Discussion of this specific technique was not found in the literature: however Rimm ('90) advocates the use of certified mail because it flushed out more non-deliverable notices and more death notices from the post office. Verification of address by telephone may have had some of the same effect.

This survey also incorporated many techniques from the published literature. For example, many efforts were made to respond to the social status of the physician respondents, as Aday ('89) and others recommend. The cover letter from the local Chapter Chairman of the AAP was included not only to give the survey the imprimatur of a respected organization but also to have the survey introduced by a known colleague. Furthermore, pediatricians' need and desire for information as well as anonymity were acknowledged by including a postcard that could be returned separately should the respondent want a

report of the study results. Confidentiality was further assured to all respondents to enhance any tendency to be frank about knowledge and attitudes regarding lead testing.

Sampling technique

The sampling technique may have increased the response rate. Only AAP members were sampled and the cover letter was from the local AAP chapter chairman. Because of their membership in the AAP, respondents in this survey may have been unusually motivated to respond. The sample also included only pediatricians who were listed as primary care practitioners by the CMA. The CMA list provided a means to eliminate at least some specialists from the survey. Since the CDC's recommendations for universal lead testing were ideally meant for primary care pediatricians, and since, again ideally, any child seen by a specialist would have seen a primary care physician first, it was felt that targeting the survey to primary care pediatricians would improve the survey's efficiency.

The cross-referencing technique was also used to increase the number of correct up-to-date addresses. Specifically, the CMA list was supposed to include pediatricians whose licenses were up-to-date and not those who have let them lapse, such as retirees. These aspects of the sampling technique used in this survey may have enhanced the response rate.

Limitations of the study

The study group selected for this survey may not represent all pediatricians. The study sampled only pediatricians who were members of the AAP, who were licensed to practice pediatrics in California, and who were practicing primary care in either Alameda or San Francisco Counties. Many pediatricians are members of the AAP largely because of the continuing medical education programs the organization sponsors. All pediatricians licensed to practice in California must take at least 12 Continuing Medical Education (CME) units every two years to qualify for a license. The AAP is seen by many as an organization that facilitates fulfilling this requirement. One could argue, therefore, that Academy members may be better educated about such recommendations as those put forth by the CDC; the AAP has sponsored panel presentations on this topic. However, since all pediatricians must take CME units to stay licensed, AAP membership probably yields little if any knowledge bias.

The sample excludes those not licensed to practice pediatrics in California. It is unclear how representative pediatricians practicing in California might be in terms of knowledge or practice trends.

The San Francisco and Alameda County area have been the focus of several studies of lead poisoning in children conducted by the state Department of Health Services. The

publicity surrounding this work may have heightened interest or at least awareness of the issue among local pediatricians, in and of itself, perhaps elevating the response rate. Interest in the subject matter is evidenced by the fact that 132 of the 244 pediatricians in this sample (54%) returned the enclosed postcard requesting a copy of the findings of the survey.

Finally, although no significant difference could be found among the demographic features of survey recipients responding to the different mailings, only two demographic features could be examined when the respondent group was compared to non-respondents as the majority of them could not be contacted. The fact that there were no demographic differences in the respondents according to the mailing they responded to may imply that there would be no demographic bias in a study of the same group with a lower response rate. It is unclear, however, if some details of demographic bias may remain hidden from analysis in the non-respondent group.

Conclusion

This study shows that an excellent response rate from physicians can be achieved by using a survey conducted exclusively through the mail. Researchers do not have to resort to truncating the questionnaire or mixed strategies such as mail combined with telephoning to attain a high response rate. The labor and cost needed to get a good

response rate in this study were reduced by focusing intensive efforts only on those who remained non-respondents after two mailings.

In general, this survey shows that with attention to timing, subject matter, and the careful use of techniques for increasing response, one can achieve a high response rate and minimize potential bias in a survey of physicians by mail. In a time of potential change in medical care delivery in this country, such an easy approach for compiling feedback from practitioners in the field may prove valuable for health policy development.

* * * * *

In the next chapter, findings of the survey will be presented.

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Chapter 3.

Blood Lead Testing by Pediatricians: A Survey

Abstract

Objectives:

1) To determine the rate of adherence by primary care pediatricians to the Centers for Disease Control's recommendation to perform universal blood lead testing. 2) To determine if specific characteristics of the pediatricians or their patient populations are correlated with the tendency to do universal testing.

Methods:

Design: Self-administered mailed questionnaire.

Setting: California counties of Alameda and San Francisco.

Participants: Pediatricians actively providing primary care to children residing in the study area.

Results:

Of the 180 eligible pediatricians, 155 (86%) responded. 27% of the study group reported routine testing of their patients. Bivariate analysis revealed that pediatrician characteristics correlated with routine testing were (1) knowledge of the CDC recommendations and findings regarding blood lead ($p < .001$); (2) completion of residency after 1988 ($p = .001$); (3) practice in an academic setting compared to a small private group ($p < .0001$) or an HMO ($p = .007$); (4) having higher proportions of minority (non-white) race patients ($p = .001$); and (5) having higher

proportions of publicly-funded patients ($p < .001$). An attitude correlated with the tendency not to test children universally was the belief that it was not necessary for the patients.

Conclusion:

This study reveals a widespread lack of compliance with the CDC recommendation for universal blood lead testing of pediatric patients. This lack of compliance appears to be associated with the belief that white privately funded patients are not at risk for lead poisoning.

Introduction

In October of 1991 the Centers for Disease Control and Prevention (CDC) published a statement recommending universal blood lead testing of all pediatric patients at 12 months of age (CDC '91). The Statement which was supported by recent recommendations by the American Academy of Pediatrics (AAP 1993) proclaimed lead poisoning the most significant pediatric environmental problem facing the nation, and it included findings that blood levels as low as 10 ug/dcl could cause deficits in cognitive functioning that are recognizable over time. Furthermore, the Statement noted that the blood lead level of 10 ug/dcl yields no symptoms that would present in a clinic setting. The recommendation to test all children for blood lead remains controversial (Baghurst, Bellinger, Goldman, Goldstein, Husman, Sciarrillo, and Silbergeld '92 versus Schoen '92 and Cunningham, Ernhart and again Schoen '93).

In a recent study conducted in Virginia, most pediatricians lacked knowledge about lead toxicity and only one in eight routinely screened patients (Bar-on '94). However, there appear to be no studies that have attempted to test the response to the CDC findings and recommendations or to correlate physician or patient practice characteristics with lead screening practices.

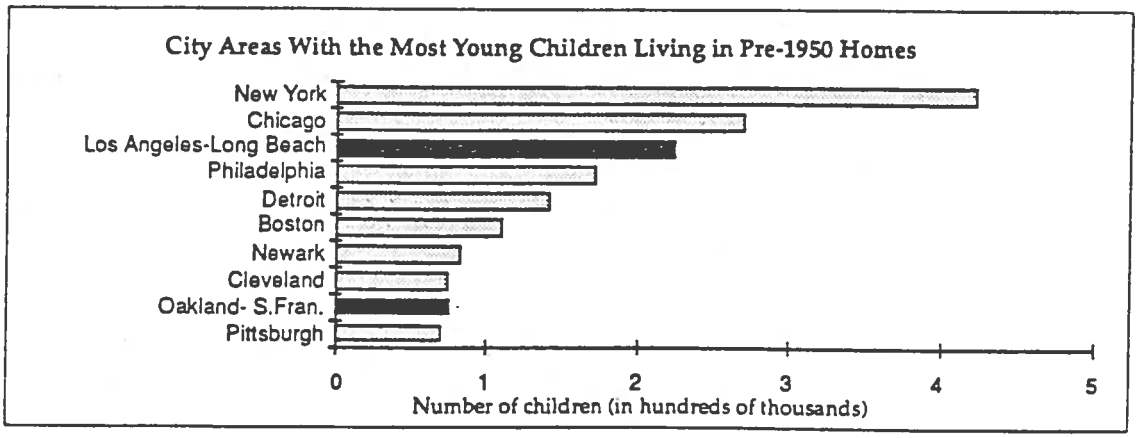
Improving adherence to lead screening recommendations will require a better understanding of why physicians often

do not screen patients. Policy makers need to know whether the failure to routine screen reflects ignorance of the official recommendation, skepticism about the scientific justification for the policy, or belief that the guidelines do not apply to one's own patient population. The purpose of this study was to elucidate these associations so that policy makers can better focus educational efforts. The goals were to (1) determine the proportion of pediatricians adhering to lead screening guidelines in a metropolitan area; and (2) to identify physician and patient population characteristics associated with the decision to routinely screen children for blood lead or not.

Alameda and San Francisco Counties were chosen for the setting for this study because, in the late 1980's a study conducted by the California Department of Health Services (CDHS) showed that the area had a high rate of children at risk for lead poisoning (CDHS '91).

Figure 1.

Ten United States Metropolitan Areas with the Most Children aged 6 Months to 5 Years Living in Homes Built Before 1950



Consideration was given to analyzing whether a pediatrician's tendency to do blood lead testing universally was correlated with lead exposure in the immediate geographic area. It might have been interesting to test whether pediatricians practicing in urban areas were more likely to test blood lead than were those practicing in sub-urban areas, for example. But, aside from the fact that one's patients often do not come from the immediately adjacent geographic area (Large university centers may see patients from all over the country.), no one knows the lead levels of all areas of Alameda and San Francisco Counties. High rates have been demonstrated through blood lead tests of selected children living in the two-county area (CDHS '90, '92), but more detail than that is not readily

available. CDHS has developed a surveillance system which consists of lab reports of positive findings (>=25 ug/dcl) on blood lead test samples (CDHS '92). As of 1992, this database was beginning to comprise a crude pattern of exposure. However, this database only contains information on the few children who are tested, not all children, so in this urban-suburban area, these data cannot be used for plotting geographic exposures (CDHS'92).

An attempt to address this issue was made by including the race of patients, health-care funding type (private vs. public), and the physician's practice setting in the questionnaire. It should be remembered that the entire study area has been considered high risk (CDHS '91). Therefore these demographic patterns should be thought of as minor sub-patterns in a general population in need.

Methods

A sample of pediatricians practicing in San Francisco and Alameda Counties was compiled through cross-referencing a list of American Academy of Pediatrics members with a list compiled by the California Medical Association of all pediatricians delivering primary care in Alameda and San Francisco Counties (n=244). Pediatricians were included in the sample only if they appeared on both mailing lists. A 14-item questionnaire was developed and pretested on a group of 60 medical students, faculty, and private pediatricians. Each of the pediatricians in the study group was then sent

by first-class mail the final version of the questionnaire in April of 1993. Two follow-up mailings were sent to non-respondents during the next 8 weeks.

The questionnaire asked each physician what percentage of their patients under age 6 had had a blood lead test. It asked about their usual blood lead testing practice and it tested their knowledge of three facts about blood lead. In addition, using a Likert-type scale, the survey asked respondents to rate their agreement with five statements regarding lead testing. Last, the questionnaire requested demographic data about the physician and his or her patient population.

Statistical analysis was performed using the chi-square test for associations between categorical variables (for example, gender) and whether a physician routinely tested patients for blood lead. The Wilcoxon rank-sum test (Mann Whitney U for two groups and Kruskal-Wallis for three groups) was used to test differences between groups on ordinal variables such as time since completion of residency and proportion of patients insured by Medicaid.

Measures

Of the 180 eligible pediatricians, 155 (86%) responded. Table 1 below displays the demographic characteristics of the respondents as a whole.

Table 1.

Demographic Characteristics of Pediatrician-Respondents

	n	%
Gender		
Male	103	57%
Female	77	43%
Race		
white (Caucasian)	123	80%
non-white (includes Hispanic)	31	20%
Date Completed Residency		
Since 1988	50	28%
1983-1987	25	14%
1978-1982	19	11%
Before 1978	84	47%
Practice setting		
Private practice	99	64%
HMO	28	18%
Clinic / academia	27	18%

The respondent population in this study differs from that in the study by Bar-on ('94) in that it includes larger proportions of non-white physicians and female physicians. All physicians in this study are primary care practitioners. The median year training was completed is roughly 1978, the same as that seen in the Bar-on study.

Table 2 below displays information on the characteristics of the pediatricians' patient populations. The Bar-on study did not examine the patient populations of the respondents.

Table 2.

Characteristics of Patient Populations

Percent Medicaid or County-funded	n	%
Fewer than 10%	68	44%
10-25%	39	25%
26-50%	18	12%
51-75%	10	6%
More than 75%	20	13%

Percent non-white (non-Caucasian) racial group		
Fewer than 10%	18	12%
10-25%	34	20%
26-50%	54	35%
51-75%	32	21%
More than 75%	20	13%

The demographic variables of the respondents according to which of the three mailings they responded to is displayed in Table 3. This table also lists non-respondents. The respondent groups did not vary significantly according to any of the variables tested.

Table 3.

Demographic Characteristics of Respondents By Timing of Response

	A		B		C		D	
	n	%	n	%	n	%	n	%
Gender								
F:M	42:58		16:20		7:12		12:13	
(% female)		42%		44%		37%		48%
Race								
white:non-white	82:18		27:8		14:5		(unknown)	
% white		82%		77%		74%		
Date Residency completed								
Since 1988	30	30%	7	19%	5	26%	8	35%
1983-1987	14	14%	6	17%	2	11%	3	13%
1978-1982	10	10%	2	6%	3	16%	4	17%
Before 1978	46	46%	21	58%	9	47%	8	35%
Practice setting								
Private practice	60	61%	25	69%	14	74%	(unknown)	
HMO	21	21%	4	11%	3	16%	(unknown)	
Clinic / academia	18	18%	7	19%	2	11%	(unknown)	

Caption Those who responded after the first mailing are designated 'A' those who responded after the second mailing 'B', those who responded after the third mailing 'C'; and non-respondents 'D'. When the variables of gender, race, date residency was completed, and practice setting were considered, no significant difference was found between the groups responding to the various mailings.

Results

Knowledge of CDC findings and recommendations:

Though 72% of respondents knew the CDC recommendation to test all asymptomatic children for blood lead levels at 12 months, only 64% knew the lowest blood level associated with deficits in cognitive function (10 ug/dcl). On the other hand, 92% knew that children with the lowest harmful level were usually asymptomatic. Knowledge of these CDC findings and the recommendation for universal testing was correlated with reports of routine testing ($p < .001$).

Blood lead testing practice

Pediatricians reported varying degrees of adherence to the CDC recommendations for universal testing. Only 42 pediatricians in the study group reported ordering tests routinely for children under age 6 (27%); 50 reported ordering tests based on answers to a published questionnaire listing lead poisoning risk factors (32%); 94 reported ordering tests for patients considered at risk, for example based on race/ethnicity, poverty, housing conditions, or use of folk remedies (61%); 114 reported ordering tests when the child shows symptoms or has had lead poisoning in the past (74%); and 16 reported generally ordering no tests at all (10%).

Physician characteristics associated with routine testing

The practice of testing all patients under age 6 was significantly correlated with several demographic

characteristics, as shown in Table 4 below. First, routine testing was correlated with pediatricians who had completed residency fewer than five years before filling out the questionnaire, that is, since 1988 as opposed to between 1983-1987, between 1978-1982, or before 1978 ($p = .001$). Second, practice setting was correlated with routine testing practice. Pediatricians who practiced in an academic setting were more likely to test routinely than were pediatricians in private practice ($p < .0001$); and those in private practice were in turn more likely to test routinely than were those in an HMO ($p = .007$). Neither pediatrician gender nor race was significantly correlated with testing routinely.

Table 4. **Pediatrician Characteristics Associated with Routine Testing**

	Pediatricians who test routinely		Pediatricians who do NOT routinely	
	n	%	n	%
Knowledge of CDC findings and recommendations				
Knew findings and recommendations	32	76%	40	35%
Did not know findings and recommendations	10	24%	73	65%
Date residency was completed				
Since 1988	21	50%	21	19%
1983-1987	5	21%	17	15%
1978-1982	3	7%	12	11%
Before 1978	13	31%	63	56%
Practice setting				
Private practice	19	46%	80	71%
HMO	0	0%	28	25%
Public or community clinic	10	24%	1	1%
Academic setting	12	29%	4	4%

Caption Pediatricians who knew the CDC findings and recommendations regarding lead were more likely to test patients routinely. Pediatricians who completed residency more recently were more likely to test patients routinely for blood lead. Pediatricians who work in an academic setting were more likely to test routinely than pediatricians in private practice; and pediatricians in private practice were more likely to test routinely than were those working in an HMO.

Attitudes about routine testing

The physician attitude most strongly correlated with the tendency not to test children universally was the belief that it was not necessary for all patients (p=.03). Concerns about the trauma of the necessary venipuncture, inadequacy of reimbursement rates, or inadequacy of public health follow-up of positive tests were not significantly correlated with tendency to test or not test routinely, as shown below in Table 5. The belief that lead testing is not necessary for the patients was correlated with pediatricians who had the highest proportions of patients who were of white race, and who were privately-funded.

Table 5. **Pediatricians in Agreement with Specific Statements About Lead Testing**

	Pediatricians who test routinely		Pediatricians who do NOT test routinely	
	n	%	n	%
Lead testing is not necessary for my patients.	8	9%	44	39%
The venipuncture necessary for a lead test is not worth the trauma to the child or the inconvenience to the parents.	4	10%	29	26%
Public health follow-up on lead poisoning cases is inadequate.	54	48%	20	48%
Medical intervention for lead poisoning is not effective.	13	12%	8	19%
Reimbursement for testing is inadequate.	27	25%	9	21%

Caption The belief that blood lead testing is not necessary for the patient was correlated with a lack of routine testing (p=.03).

Sixty-one physicians (28%) wrote comments in response to an open-ended question inviting comments about blood lead testing. Twenty-six included comments against universal testing, such as: "Universal testing is overkill." Several respondents complained about the low yield of the blood lead test. For example, "We have ordered several hundred tests and only a few had levels between 10-20ug." A few reported clinical experience that apparently fortified their resolve to continue testing: "[I] remember finding two children ... who would play on an old deck covered with paint. The youngest had elevated lead -- probably ended up with brain damage."

Patient characteristics associated with routine testing

Reports of routine testing were also correlated with specific patient population characteristics as shown in Table 6 below. Pediatricians with larger proportions of non-white (non-Caucasian) patients were more likely to test routinely ($p = .001$). In addition, pediatricians with larger proportions of patients whose health care was publicly-funded, for example through Medicaid or the Child Health and Development Program (CHDP) were more likely to test routinely ($p = .001$).

Table 6.

Patient Characteristics Associated with Routine Testing

	Pediatricians who test routinely		Pediatricians who do NOT test routinely	
	n	%	n	%
Percentage of patients who are of a non-white (non-Caucasian) racial or ethnic group				
Fewer than 10%	1	2%	17	15%
10-25%	4	10%	27	24%
26-50%	12	29%	42	37%
51-75%	15	36%	17	15%
More than 75%	10	24%	10	9%
Percentage of patients who are Medi-Cal or county-funded (CHDP)				
Fewer than 10%	7	17%	61	54%
10-25%	8	19%	31	27%
26-50%	6	14%	12	11%
51-75%	4	10%	6	5%
More than 75%	17	40%	3	3%

Caption Routine blood lead testing was significantly correlated with having a high percentage of patients who are non-white, and having a high percentage of patients whose health care is publicly-funded.

Discussion

In February of 1994 Bar-on and Boyle published their report of a survey of pediatrician knowledge about blood lead toxicity and blood lead testing practices. The Bar-on study has several similarities and several differences compared to this study.

Methods

The Bar-on study, like this one, consisted of a survey

by mail of pediatricians. The study included all pediatricians including specialists in practice in Virginia (n=1,180), a group nearly five times the size of the group polled by our survey. Our survey included only primary care pediatricians who were practicing in two counties in northern California. Though the two studies are different in that the Bar-on study attained a 56% response rate (n=661) and ours 86% (n=155), several demographic characteristics of the study groups are similar: Both groups were approximately 60% male (ours 58%), and both had a median date for completion of residency of 1978. On the other hand, our study group included 20% non-white pediatricians, a higher percentage compared to 14% in the Bar-on study.

The Bar-on study was not conducted in an area specifically known to have a large number of children at high risk for lead poisoning. Ours was. The reason for our conducting the study in the San Francisco Bay Area was to test pediatrician compliance with the call for universal blood lead testing in an area considered at high risk. If any group of pediatricians should have been primed to follow the recommendations, this one should have been.

Most importantly, the Bar-on questionnaire was distributed at the time the CDC released its statement recommending universal blood lead testing (October 1991). So the Bar-on study can be seen as a test of baseline

knowledge and practice before the CDC recommendations were widely known. Our survey, on the other hand, was conducted two years after the release of the CDC recommendations. Thus our survey can be used as a test of compliance with the recommendations.

Findings

Two years after the CDC published the recommendations for universal blood lead testing, this study found a widespread lack of compliance with the recommendations among pediatricians. It is of note that our study found such a lack of compliance in an area where a high rate of exposure to lead has been found (CDHS '91), and where there has been a great deal of interest and discussion about this matter. Our study found 27% of pediatricians performing blood lead testing routinely. The Bar-on study found an overall 12% of the study group practicing universal testing.

Like the Bar-on study, ours looked at pediatrician knowledge of blood lead poisoning issues. We also tested knowledge of the CDC recommendations, which were just being distributed when the Bar-on study was conducted. Though our study found some deficits in knowledge about lead poisoning, this did not seem to be the driving force behind the lack of compliance. Seventy-two percent of the respondents knew the CDC recommendations, yet most of even those who knew the recommendations did not follow them.

The Bar-on study did not attempt to correlate blood

lead testing practice with demographic features of the pediatricians nor their patient populations. Our study featured this.

Pediatrician characteristics correlated with routine testing were practice setting and date of completion of residency. Pediatricians practicing in an academic setting were most likely to test, those in private practice were less likely, and those in an HMO were the least likely. It is noteworthy that a leading opponent of lead testing is the former Chief of Pediatrics in one of the larger HMOs in northern California. This obviously could influence practice patterns.

Second, pediatricians who completed residency more recently were more likely to test routinely. Some may find it a promising sign that pediatricians practicing in academic settings, and those who completed residency most recently are the most likely to provide universal blood lead testing. This result may indicate that not only are educators promoting the CDC findings both in practice and in their teachings, but the traditional medical education system seems to be succeeding in providing convincing evidence to encourage young physicians to provide blood lead tests routinely. In comparison, pediatricians who have been in practice for a longer time may rely more heavily on their clinical experience; they may be more skeptical of the scientific findings.

The physician attitude that blood lead testing is not necessary for the patient population was correlated with not testing routinely. Other factors, such as the inconvenience of venipuncture or the inadequacy of reimbursement for testing, did not correlate with testing practice. The policy implication is that physician education groups need to spend more time changing physician attitudes about blood lead testing; other postulated barriers, such as those mentioned above, do not seem as important.

Patient characteristics also predicted routine testing. Pediatricians with high proportions of non-white patients, and those with high proportions of patients whose health care is publicly funded are more likely to test for blood lead routinely. Some researchers believe this might be appropriate (Harvey '94).

Study limitations

This study is limited by its small sample size and small geographic area. The area has been found by the State Department of Health Services to be at high risk for lead poisoning; there has been widespread publicity about this fact. This may have created a bias in that pediatricians in this study may be better informed about lead than their colleagues practicing elsewhere in the nation. On the other hand, one could consider this study's setting as the best possible world for compliance with the CDC recommendations. Pediatricians in this area should be some of the most

enthusiastic about blood lead testing and some of the most compliant. Since only 27% reported universal testing, this study provides evidence that there are substantial over-riding factors that are limiting compliance.

Conclusion

Based on this study's findings the CDC may wish to develop education programs about blood lead poisoning that are targeted to physicians with specific demographic characteristics. Those who completed residency before 1978, who are in private practice or an HMO, and those who see primarily white (Caucasian) patients appear to be the least convinced that universal lead testing is necessary. Multivariate analysis of these data may provide information that could further target pediatricians who are resisting blood lead testing. Pediatrician education programs should work to counter the attitude that lead testing is not necessary for certain patient populations. Specifically, research showing that white, privately-funded patients are also at risk for lead poisoning, such as the research by Dietrich ('93), Kirchner ('91) Baghurst ('92) and Binns ('94) needs to be developed and distributed.

* * * * *

The last chapter provides an overview of the major findings of the survey described in this chapter. It includes comments about the significance of the findings.

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Chapter 4.

The Pediatrician's Response to the Call for Universal Blood Lead Testing

In the spring and summer of last year, 244 pediatricians practicing in Alameda and San Francisco Counties were sent a questionnaire about blood lead testing. The questionnaire was part of a survey I was conducting to determine the extent of compliance with the two-year-old recommendation for universal testing from the Centers for Disease Control and Prevention (CDC).

As many of you know, the CDC issued a statement in October of 1991 proclaiming lead poisoning the most significant pediatric environmental issue facing the nation (CDC 1991). This statement estimated that 4 million children in the US were believed to have blood lead levels upwards of 10 ug/dcl, a new low level that recent research had shown is associated with deficits in cognitive development. Though earlier CDC statements on lead had set first 35 ug and then 25 ug/dcl as the harmful level, the 1991 statement was issued partly in recognition of new laboratory technologies as well as new neurologic evidence showing that the 10 ug/dcl level is indeed hazardous (CDC '91, Bellinger '91, Dietrich '91, Needleman '90).

The statement explained that though children are exposed to lead by routes including imported pottery, folk remedies, and pica behavior, the most pervasive source of

lead for an infant is dust formed by deteriorating leaded paint.

The survey was conducted to measure the response of primary care pediatricians to the CDC's call for universal testing. Specifically, the purpose of the study was five-fold: 1) To determine the prevalence of knowledge about the CDC's findings and recommendations concerning blood lead; 2) to determine the degree of pediatrician compliance with the CDC recommendations; 3) to determine if the tendency to test children universally could be correlated with specific characteristics of pediatricians, (4) to determine if the tendency to test could be correlated with specific characteristics of the patients and (5) to determine if the tendency to test could be correlated with specific attitudes lead about testing.

Of the 244 pediatricians who were sent the questionnaire, 219 responded, representing a 90% crude response rate. One hundred and eighty of these respondents were found to be eligible for data analysis. Pediatricians were considered ineligible if they were retired, if they did not deliver primary care to children, or if they did not practice in Alameda or San Francisco Counties. Excluding those ineligible, the study group consisted of 180 pediatricians, an overall 86% response rate.

The 25 non-respondents did not differ from the respondents in terms of gender or date of completion of

residency. Other characteristics could not be studied because the majority of these individuals could not be reached. This brief analysis of the non-respondents implies that limited, if any, bias exists in the self-selection of those who responded.

These are the study findings:

1. 73% of the study group knew that the CDC recommended universal blood lead testing. Knowledge of the CDC's specific findings regarding lead, however, were mixed. Only 64.5% answered correctly that 10 ug/dcl was the lowest blood lead level the CDC found associated with deficits in cognitive function. Fully 92.9%, however, answered correctly that the lowest harmful level yielded no symptoms on clinical presentation; the child appears well.

Knowledge of these three facts was found to be correlated with a tendency to test children routinely ($p < .001$).

2. Only 27% of the study group were providing universal blood lead testing. Roughly one-third (32.3%) of the study group reported ordering tests based on answers to a published questionnaire. On the other hand, 60.6% reported ordering tests for children considered at risk for exposure based on race or ethnicity, poverty, housing conditions, or use of folk remedies. Most of the study group (73.5%) reported ordering tests when the child shows symptoms or has had lead poisoning in the past.

3. Reports of universal testing were correlated with specific pediatrician characteristics.

First, the age of the pediatrician was correlated with the tendency to test. Younger pediatricians, that is, those who completed their residencies after 1988, were more likely to be testing children universally ($p = .001$), than pediatricians who completed residencies between 1983 and 1987, between 1978 and 1982, or before 1978.

Second, the practice setting was correlated with reports of routine testing. Specifically, those who practiced in an academic setting were most likely to test children universally when compared to pediatricians who practice in a private group or in an HMO ($p < .001$). The race and gender of the pediatricians themselves were not correlated with the tendency to test.

4. The tendency to test children universally was also correlated with specific patient populations.

Pediatricians whose patient populations included a larger proportion of children of non-white (non-Caucasian) races were more likely to test universally ($p = .001$). Also, pediatricians whose patient populations included a larger proportion of children whose health care was paid for with public funds, such as Medi-Cal or CHDP, were more likely to test universally ($p < .001$).

5. Most correlated with a tendency NOT to test was the belief that testing is not important for the patient population ($p = .03$).

Though this rationale may seem tautological, it is interesting to note that respondents did not agree with other possible reasons for not testing that were listed in the questionnaire. These included (1) testing is not worth the trauma to the child, (2) public health follow-up is inadequate, (3) medical intervention is not effective, or (4) reimbursement for testing is inadequate. None of these latter reasons were correlated with testing practice.

The last question in the questionnaire was open-ended, asking for comments the respondent would like to add. Sixty-one respondents (28%) used this space. The most common sentiments expressed included the opinion that other kinds of care should be funded instead of lead testing (n=6); that specific high risk groups should be targeted for universal testing (n=7); and a general comment that though tests have been done, few or no tests have been positive in the particular pediatrician's practice (n=13).

This report has shown that pediatricians in Alameda and San Francisco Counties generally know the CDC findings about lead poisoning and the recommendations for universal testing. Compliance is low, however, and this failure is coupled with the belief that lead testing is not necessary in certain patient populations.

Discussion

In response to these volunteered sentiments and the general lack of compliance with the recommendation for universal testing, the CDC may wish to consider several actions. Information augmented by more recent studies may convince more pediatricians that universal lead testing is warranted. It is interesting to note that pediatricians who practice in academic settings and those who were trained more recently were more likely to test routinely. Physicians who were trained earlier may rely more on their clinical experience. Newer clinical information may be convincing. Since the CDC's 1991 statement, several studies have been published that add to the plethora of data on lead. These studies show that the 10 ug/dcl blood lead level is harmful and that this level of exposure to lead is not limited to the lowest socio-economic classes (Dietrich '93, Kirchner '91, Baghurst '92).

Since the CDC issued its statement in October of 1991, the American Academy of Pediatrics has also published a statement (AAP '93) which follows the CDC statement closely. Perhaps publicity about this determination will assist pediatricians in complying with the CDC recommendations.

It is interesting to note that while the failure to test for lead routinely is associated with the belief that testing is not necessary, other screening tests of even rarer diseases are supported by most pediatricians. For

example, the state Newborn Screening Program coordinates blood tests of all newborns for at least three inborn errors in metabolism: phenylketonuria (PKU), hypothyroidism, and galactosemia. Tests for these three diseases are performed on blood sampled by heel-stick on newborns before they leave the hospital. The rate of occurrence of these diseases in the newborn population in California from October 1980 to June 1993 was for PKU 1/25,000, for hypothyroidism 1/3,500, and for galactosemia 1/76,000 (CDHS '94). Granted a venipuncture for lead on a 12-month-old involves more complicated logistics. But the CDC has estimated the prevalence of lead at levels above 10 ug/dcl at 4 million in the total US population, a ratio of 1/63. Reducing the figures from the general population to just children lowers that ratio, increasing the chances that any pediatrician will find a child with a dangerous blood lead level. If the newborn screening program is considered cost-effective, it seems universal screening for blood lead should be too.

The February 1994 issue of Pediatrics contains several articles addressing less invasive approaches to determining which children may be at highest risk for lead poisoning. Rooney and Tejeda most notably, examine the use of questionnaires as initial screening tools. These groups showed that in low-risk populations, a questionnaire may be the best approach to determining if a particular child is at high risk. The most effective questions appeared to be

those that ask whether the home was built before 1950 and whether there are areas in the home where paint is deteriorating. This finding prompted an editorial in that same issue of Pediatrics where reconsideration of the CDC recommendations was proposed (Harvey '94). Clearly more discussion is needed about this alternative.

Arguments have been made that treatments for lead poisoning used in the past for high levels (greater than 35 ug/dcl) are not effective for levels detected closer to 10 ug/dcl (Mortensen '93). Recent research has shown, however, that newer medications such as succimer are effective at removing lead from children who have lower blood lead levels (Wegman '92, Mortensen '93). Furthermore, public health follow-up on the home site and removal of hazardous exposures may be necessary and quite effective in many low level lead poisoning cases (Wegman '92, CDHS '90).

Clearly the issue of lead poisoning and how to respond to it remains controversial. Readers in practice now, given some limited information, need to ask themselves "What is it worth to find a child who is lead-poisoned?" Detection and intervention of equally harmful but more rare conditions, as mentioned above, is seen as worthwhile. If left untreated, each of these diseases, like lead poisoning, can lead to serious developmental delay.

So many health and societal problems that children face seem unsolvable. Lead poisoning is a rare issue where

physicians can request a simple blood test, detect a problem, and intervene to brighten the future of a young child. It is difficult to place a value on the finding of just one child who is lead poisoned. Surely the cost is worth many blood tests.

I think lead testing is important, it's valuable, and it's a way physicians can make a real difference in people's lives. Until more research on alternative approaches to screening is complete and then fully considered by agencies such as the CDC and the AAP, universal screening remains the most fail-safe way to prevent lead poisoning.

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