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Physician Opinions and Practices Regarding Childhood Lead Screening

by

Dennis John Kuo

B.A. (Harvard University) 1995

A thesis submitted in partial satisfaction of the  
requirements for the degree of

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in

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in the

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of the

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Committee in charge:

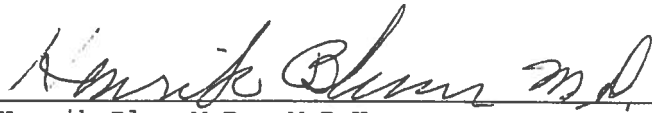
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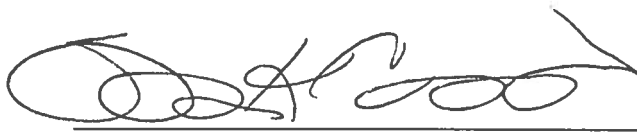
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Spring 1998

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Spring 1997

Physician Opinions and Practices Regarding Childhood Lead Screening

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November 19, 1997

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RE: "Physician Practices and Attitudes Regarding Lead Screening" Graduate Research - Health and Medical Sciences, Joint Medical Program

Thank you for the statement and request for exemption that you submitted to the Committee for the project referred to above. As described in the statement, your research satisfies the Committee's requirements under Exemption #6, page 15, of CPHS Guidelines of September 1996 (Exemption #4 of the Federal Regulations.) Accordingly, the project is exempt from full Committee review provided that there are no changes in the use of human subjects.

For our records, the number of the project is 97-12-73. Please refer to this number in any future correspondence about the project.

If you have any questions about this matter, please contact the CPHS staff at 642-7461; FAX 643-6272; Email subjects@uclink.berkeley.edu.



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cc: Professor Henrik Blum  
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and

Mom, Dad and God, whose love I depend on for life each and every day.

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## **List of Abbreviations**

AAP: American Academy of Pediatrics

AAFP: American Academy of Family Physicians

BLL: Blood Lead Level

CDC: Centers for Disease Control

CLPPB: Childhood Lead Poisoning Prevention Branch, California  
Department of Health Services.

NHANES: National Health and Nutrition Examination Survey

RBA: Risk Based Assessment

SD: Standard Deviation



## CHAPTER 1: Introduction

Lead, due to its physical and chemical properties has found its way into almost every industry and home. Lead has been widely used since ancient civilizations in cosmetics, medicines, paints, glazes, sweeteners, wine stabilizers, sculptures, pipes, gasoline, and food and beverage containers. Although ancient sources show that the symptoms of lead poisoning were well recognized, that did not hinder lead's extensive use and distribution. A 1839 publication in Paris was one of the first in the modern era to bring the issue of lead to the public's attention.<sup>1</sup> Since then much more evidence has demonstrated that lead has toxic effects on many organ systems including the nervous, digestive, hematopoietic, skeletal, and renal systems.

Lead that has been aerosolized in the form of dust or vapors is deposited into the arctic snow. Measurements of atmospheric lead by arctic ice cap measurements show that worldwide atmospheric lead has been increasing since the beginning of human civilization.<sup>2</sup> Lead production increased especially quickly during the industrial revolution and most recently, and through the introduction of lead into gasoline, where it is added as an anti-knock agent.

### *Sources of Lead Poisoning*

In America the main sources of childhood lead poisoning are chipping lead containing paint in old houses, lead-contaminated soil from deteriorated lead paint, lead-related industries and leaded gas emissions, imported pottery, lead dust brought home by parents working in lead related industries (e.g. auto repair, soldering, battery production), and folk medicine.

Lead poisoning historically was considered an occupational hazard for those who worked in lead-related industries.<sup>3</sup> It was the advent of lead paint that brought widespread numbers of children into contact

with lead.<sup>4</sup> Ironically lead was supposed to make paint more durable. However, lead paint, just like any other paint cracks and peels, and when it does it can be ingested by children as lead paint flakes or as lead dust contaminating food or other things children put in their mouths. The first modern childhood cases of lead poisoning reported were from Australia and were due to lead paint.<sup>5</sup> As a result lead paint was banned in Australia since the first decade of the twentieth century. However, lead-based paint (paint with lead concentrations over 5000 parts per million) was not banned in America until 1977, when the United States Consumer Product Safety Commission (CPSC) set a maximum allowable lead level in residential household paint. A year later the "CPSC banned the use of paint exceeding this level on residential structures, toys, furniture, and cooking and eating utensils."<sup>6</sup> While this reduced the introduction of new lead into the residential environment, it did little to address the issue of lead in the previously built housing stock.

Lead in paint is the most common source of childhood lead exposure in the US.<sup>7</sup> About "83% of all homes built in the United States before 1978 still contain some lead-based paint at a concentration of at least one mg/cm<sup>2</sup>."<sup>8</sup> Children from birth through the third year of life are in the oral-motor stage of development and explore the world by putting things in their mouths. Lead in chipping paint can thus be ingested by children, who perceive the lead paint chips to be sweet tasting. Alternatively, lead dust from chipping lead paint, lead-contaminated soil, or parents who work in lead-related occupations or do lead-related hobbies can be ingested by children who bite their nails, suck on their fingers, or eat with unwashed hands.<sup>9</sup> Unfortunately, chronic lead exposure at this age has important long-term neuro-developmental consequences.

The use of lead in gasoline as an anti-knock agent introduced large quantities of lead into our atmosphere which became part of the dust that is inhaled into our bodies and deposited into our food and water supplies.<sup>10</sup> Although fatalities and lead poisoning were observed early during the development of tetraethyl lead for gasoline, such concerns were dismissed by a committee formed by the Surgeon General to study the issue, thus allowing lead to be used in gasoline.<sup>11</sup> In 1973 the Environmental Protection Agency began to regulate the levels of lead in gasoline. NHANES II, the Second National Health and Nutrition Examination Survey, which was conducted from 1976 to 1980, correlated the decrease in US consumption of lead in gasoline with a decrease in the mean blood lead level of the US population.<sup>12</sup> This data was "instrumental in forcing the Environmental Protection Agency (EPA) to face the issue of lead pollution from gasoline more directly."<sup>13</sup> In 1982 the EPA "proposed an aggressive phased reduction of lead in gasoline."<sup>14</sup> While the lead hazard in gasoline has been drastically reduced, the residua of decades of leaded gasoline are still present in the contamination of soil especially near freeways.

Since lead is toxic, it is useful for its antiseptic properties and can be found in traditional medicines; however, just like many antibiotics used today in medicine, lead has toxicities for the host as well as for the parasite. The use of lead in medicines may date as far back as 6000 BC in Egypt.<sup>15</sup> Indeed, lead's use in medicine was ubiquitous, ranging from West Africa, to Mesopotamia, to India, to China. While it may seem odd that a toxin has been used for medical purposes, it is humbling to remember that allopathic chemotherapeutic medicines until the turn of the century were largely composed of toxins such as mercury, phenol, arsenic, and lead.<sup>16</sup> In America, folk medicines among foreign-born populations from Latin America and Asia

continue to cause significant levels of lead poisoning among children.

*The Toxicity of Lead*

While there is no unifying hypothesis for the toxicities of lead, large amounts of clinical and experimental data show that lead levels as low as 10 micrograms per deciliter of whole blood can have adverse effects on a number of organ systems.<sup>17 18</sup>

At higher blood lead levels patients may present acutely with symptoms that are often attributed to other causes. Blood lead levels greater than 80 mcg/dL can cause comas, convulsions, and death. Above levels of 50 mcg/dL people may get colic, anemia, nephropathy and encephalopathy. At 20 mcg/dL hemoglobin synthesis is reduced, vitamin D metabolism is impaired and nerve conduction velocity decreases.<sup>19</sup>

Lead poisoning today is most commonly a silent, chronic disease whose effects are not seen until years of chronic damage accumulate.<sup>20</sup> Low-level lead poisoning is also associated with increases in adults in hypertension and renal disease.<sup>21</sup> One of the most important complications of chronic lead poisoning is its neurotoxic effect on the brain. Many international cross-sectional and retrospective studies have shown that "decrements in children's cognition are evident at blood lead levels well below 25 mcg/dL. No threshold for the lead-IQ relationship is discernable from these data."<sup>22</sup> "In reviewing the recent literature, the U.S. Environmental Protection Agency (EPA) concluded that blood lead levels exceeding 50 mcg/dL are associated with a five point decline in IQ, levels of 30 to 50 mcg/dL with a four point decline, and levels of 15 to 30 mcg/dL with a decline of perhaps one to two points. ... Because of the sigmoid shape of a normal cumulative frequency distribution, however, a shift of four to seven points in the mean can represent a fourfold difference in the percentage of children in the extreme tails of the distribution."<sup>23</sup>

Other studies have shown that low level lead exposure in early childhood is associated with neurobehavioral dysfunctions and a markedly higher risk of dropping out of high school, increased absenteeism and of reading disabilities.<sup>24</sup>

*Historic Overview of Public Health Interventions Regarding Lead.*

Although the toxicity of lead was mentioned in medical literature dating back to ancient Rome and reports of lead poisoning were present in the early twentieth century, lead poisoning was not taken seriously by society until the latter half of this century. "Screening data collected in the late 1960s and early 1970s revealed that 20 to 25% of children tested had blood lead levels that exceeded 40 mcg/dL."<sup>25</sup>

In 1971 the Lead-Based Paint Poisoning Prevention Act created a categorical grant program for community-based lead screening and treatment. "The act initiated a national effort to identify children with high blood lead concentration and to attempt abatement of their environmental sources of lead."<sup>26</sup>

In 1975 the blood lead level of concern was lowered to 30 mcg/dL. This marked the transition from viewing childhood lead poisoning as an acute poisoning problem to that of a chronic poisoning problem. Before 1975 lead poisoning treatment efforts were directed towards the tertiary care of children who were acutely ill with lead colic, nephropathy, and encephalopathy who were in danger of death. This treatment largely centered around treatment with lead chelating agents in hospital-based settings. As the average blood lead level decreased, such manifestations of acute lead poisoning became more rare and the emphasis moved towards secondary prevention of lead poisoning. This involves the screening of children to discover who has unacceptably high blood lead levels (which is a measure of recent lead exposure) and the identification and removal of lead hazards from the environments in

which they live. The goal here is to prevent developmental deficits such as attention deficits, reduced IQ, and reduced growth.

The 1981 Maternal and Child Health Services Block Grant Act and Omnibus Budget Reconciliation Act let each state determine whether to support lead screening activities. As a result, categorical funding for lead poisoning prevention activities decreased along with public awareness. For much of the 1980's lead poisoning was considered an issue of the past since children with symptomatic lead poisoning were less common. This gave the nation the opportunity to concentrate on preventing chronic low-level lead poisoning. However, physicians who remembered the era of rampant lead poisoning were likely to underestimate the harmful effects of low-level lead poisoning. So rather than moving the focus to chronic lead poisoning, many physicians were content with the progress already made and made lead screening a low priority in well-child visits. However, research throughout the 1980's, when the average blood lead level were dropping, suggested that the problem of lead could not be so readily dismissed.

"During the past 15 to 20 years, due to mass screening, public education, a phased reduction of lead in gasoline, and a decline in food lead content, overt lead poisoning has decreased dramatically."<sup>27</sup> As time has passed it has become possible to study the effects of lower levels of blood lead on development.

When the average blood lead level was high, it was impossible to study the effects of low levels of blood lead. As the average population lead level decreased, researchers found that progressively lower blood lead levels were associated with significant adverse health effects. In 1975 the CDC revised the definition of lead toxicity from 40 mcg/dL to 30 mcg/dL. In 1985 the CDC reduced the blood level of lead considered toxic again to 25 mcg/dL with an understanding that

adverse effects were seen at lower levels also. The CDC in 1991 further defined a lead concentration of 10 mcg/dL in whole blood to be an elevated level. In conclusion, the studies through the 1980's suggested that increased blood lead levels are associated with decreased IQ, and that there is no safe threshold for blood lead.<sup>28</sup>

#### *A Broader Perspective on Lead Poisoning*

Lead is not just a neurological development issue. Lead poisoning prevention touches on many public health and social justice issues and can be used as a vehicle for improvement of the health of many poor children.

A number of factors make lead a good target for attention among the large numbers of environmental toxins that could be addressed. First, "virtually all children in industrialized nations have chronic exposure to lead. Many carry lead burdens that are disturbingly close to those at which health is compromised."<sup>29</sup> Currently approximately 890,000 US children have blood lead levels greater than 10 mcg/dL.<sup>30</sup> Mitigating this large cause of learning disability would significantly reduce our society's medical and educational costs, and also improve the quality of life for many families. Second, relatively low-technology methods can be used to prevent further lead exposure once a child is determined to be lead-burdened.

Third, while all children are potentially at risk for lead poisoning, the epidemiology of lead poisoning shows that lead poisoning is more common among the poor and underprivileged minorities, thus bringing in the question of social justice. Poor children are more likely to live in old housing with chipping lead paint, live on lead contaminated land, live near sources of lead pollution (factories and highways), or have parents working in lead-related industries. Furthermore, lead is more easily absorbed in children who are calcium

or iron deficient and underprivileged children are more likely to have such nutritional deficiencies. Poor children have enough disadvantages in their under-funded schools. Adding on IQ-reducing lead burdens further decreases their chances of success in our increasingly education oriented economy. Thus addressing issues of lead poisoning also calls attention to issues of poor children's access to quality nutrition, medical care, housing, and education, with the end result of improving the children's physical health, emotional health, and educational potential.

#### *Prevalence of Lead Poisoning and Screening*

The 1981 Maternal and Child Health Services Block Grant Act and Omnibus Budget Reconciliation Act let each state determine whether it would fund lead screening. This resulted in less centralized screening efforts with no nationwide systematic data collection. Since there has never been a comprehensive program of universal screening, and there has been no centralized effort to collect lead screening results the data on lead poisoning prevalence is incomplete and patchy. However the NHANES III (the Third National Health and Nutrition Examination) data give us a glimpse of the prevalence of lead poisoning.

Despite the reduction of childhood lead exposure over the past two decades and lead's low public profile, childhood lead poisoning is not rare. NHANES III Phase II (1991-1994) found that the mean blood lead level in children ages 1-5 years old was 2.7 mcg/dL. This signifies a huge improvement over findings from NHANES II (1975-1980) when mean blood lead levels were 15 mcg/dL. However, the NHANES III Phase II distribution of children's blood lead levels suggests that approximately 4.4% of the children from 1 to 5 years of age have elevated blood lead levels (greater than 10 mcg/dL), and that minority, poor, and urban children are particularly at risk.<sup>31</sup> In 1991 the CDC



published guidelines calling for universal child screening.

*The CDC's 1991 Guidelines and physician response*

In 1991 the CDC recognized that "because almost all U.S. children are at risk for lead poisoning (although some children are at higher risk than others), our goal is that all children should be screened, unless it can be shown that the community in which these children live does not have a childhood lead poisoning problem," and "children at greatest risk for high-dose lead exposure should be screened more frequently."<sup>32</sup> In particular, if a child is assessed as not high-risk by a questionnaire, the child should be screened at 12 months of age, and, if resources allow, at 24 month of age. If a child is high-risk then screening should start at 6 months of age with follow up screening at least every 6 months.

Despite the 1991 CDC guidelines, a 1994 national survey showed that only about one-fourth of young children had been screened and only about one-third of high-risk children, as measured by poverty or age of residence, had been screened.<sup>33</sup> Other studies showed that certain populations had very low blood lead prevalence, while others had very high prevalence. These findings showed us that doctors were resisting universal screening and that perhaps there would be a way to target screening so that lead screening resources are directed towards high-risk groups.

*The CLPPB's survey: what was the intent of the study when it was written*

In 1991 the California legislature passed a bill to expand the State's lead poisoning prevention program. Realizing that physicians had not complied with the CDC's universal screening recommendation, the California Department of Health Services Childhood Lead Poisoning Prevention Branch conducted a study to examine reasons for resistance

to screening among pediatricians and family physicians. This project will be a secondary analysis of this data set, and will seek to discover whether factors such as practice pattern, knowledge about lead poisoning, and the year the physician graduated from residency affect physician attitudes, knowledge and behavior regarding screening.

The survey serves as a useful bridge between the CDC's 1991 and 1997 Guidelines and gives the CLPPB an ability to more effectively target physician education and outreach efforts, as well as target further research funds.

First, it elucidates the reasons why universal screening was not accepted by the medical community. Second, it is a large data set with a size of 821 respondents and a response rate of 71%. Third, it can give us a forecast of what the risk-based screening approach recommended in the 1997 CDC guidelines will do to change physician behaviors.

#### *The CDC's 1997 Guidelines*

In 1997 the CDC issued new guidelines which recommend a targeted approach to blood lead screening. These new guidelines emphasize assessing community and individual risk factors using questions about the proportion of pre 1950's housing in the zip code of residence, indicators of poverty, and other lead exposures of the child at home and at school. Children who live in high risk areas or who are on public assistance programs for the poor should all be screened at ages 1 and 2. Furthermore, those who live in low-risk areas should be screened if they individually at high risk.

## CHAPTER 2: The Study Methods

### *The Survey*

The Childhood Lead Poisoning Prevention Branch (CLPPB) contracted with Duerr Evaluation Resources to conduct this survey in January 1995. A six-page survey was developed by CLPPB staff, medical experts, and survey research consultants, and field tested by 20 practicing physicians. The final survey instrument was then mailed with a cover letter from CLPPB to 1492 physicians randomly selected from the combined membership of the American Academy of Pediatrics (AAP) and the American Academy of Family Physicians (AAFP) in California, consisting of 7,150 doctors throughout the state.

The mailing included a cover letter from the CLPPB and either the AAP District IX Chair or the AAFP statewide Executive Director, depending on the affiliation of the respondent. Follow-up efforts included up to three re-mailings and repeated telephone calls.

A total of 340 respondents (22.8% of the physicians who were mailed surveys) were excluded from the sample and data analysis because they did not provide primary care for children under six years of age, who are the target population for lead poisoning screening. The overall response rate was 71 percent, with 821 of the 1,152 eligible physicians responding to the survey. As subgroups, the response rate for AAP members was 75 percent, compared to 66 percent for AAFP members. Overall, the sample yields statewide survey data that have a precision rate of +/- 3 percent at the 95 percent confidence interval.

The survey contained a variety of questions inquiring about subjects ranging from characteristics of the physician's patient population (age distribution, racial distribution, and insurance coverage), to characteristics of the physician himself or herself (year of residency graduation, professional memberships, and journal

subscriptions), to the physician's attitudes regarding lead poisoning and lead screening, to physician screening behaviors (current practices and changes in practice). A copy of the survey can be found in the Appendix II.

#### *Research Questions and Predictor Variables*

This research project is a secondary analysis of this data set. The analysis was designed to address the research question, "What factors affect physician screening behavior?" This is a key question in addressing lead poisoning because only regular screening will allow detection of children who are chronically burdened with low-level lead poisoning.

I hypothesized that a number of variables would be significantly associated with lead screening behavior. Since this is a cross-sectional study it is not possible to definitively show causation between any predictor variables and outcome variables. This is because in a cross-sectional study it is difficult to reliably establish the temporal relationship between an observed association of a predictor and outcome variable.

#### *Predictor Variables*

##### *a. Physician Specialty*

The two groups of physicians in the study are pediatricians and family physicians (family practitioners), who are the physicians that care for most children under age 6. Physicians who were from the AAP mailing list were considered pediatricians and those from the AAFP mailing list were classified as family physicians.

Pediatricians differ from family physicians in their training and practices, and were thus analyzed separately. Pediatricians go through residency for three years concentrating on children's health. Family physicians cover material from at least four disciplines: internal

medicine, pediatrics, obstetrics and gynecology, and surgery in their training of three years. For this reason it was hypothesized that pediatricians would have more training regarding the identification, clinical management and health consequences of childhood lead poisoning.

Pediatricians and family practitioners have different practices. This in itself may affect how much familiarity these physicians have with children's health issues. Lead screening is supposed to be performed by doctors who are giving general primary care to young children, preferably at ages 1 and 2.

Family practitioners and pediatricians also practice in different practice settings. In general, family practitioners practice more frequently in small groups, and more pediatricians practice in hospitals and medical school than family practitioners do. Pediatricians and family practitioners as two groups may also tend to work in different practice settings and see different numbers of minority and poor patients.

Given that pediatricians and family practitioners have different training and practice types it would be reasonable to test the hypothesis that pediatricians and family practitioners have different attitudes and behaviors towards childhood lead screening. This important influence on lead screening behavior should be controlled for by stratification in any analyses of other variables so as to avoid its confounding the test variables.

*b. Percent of Patients Covered by CHDP*

The second predictor variable is the percentage of patients who are covered by Childhood Health and Disability Prevention Program (CHDP), as reported by the physicians in the survey. Knowing that lead poisoning is associated with poverty, it made sense to investigate if

the poverty rate in a physician's population would have effect on the physician's behavior. The measure that we used to measure poverty is the percentage of pediatric patients that are covered by CHDP (the California version of the federal Early and Periodic Screening Diagnosis and Treatment Program (EPSDT)). This variable is useful because it serves two different functions. First CHDP is an accurate assessment of poverty, because CHDP covers children whose families are within 200% of the poverty line. Second, the California Department of Health Services was sued in 1991 by a mother of a CHDP patient for not providing lead screening.<sup>34</sup> As part of the settlement, the Department of Public Health deemed that all CHDP patients at the appropriate ages must be screened for lead poisoning. For both these reasons it is expected that an increased percentage of patients covered by CHDP would be associated with more patients being screened for lead poisoning.

*c. Residency Graduation Year*

The third predictor variable is the year of residency graduation, which was reported in the survey by the physicians. The blood lead level of concern has dropped over the past few decades. As a result the level of concern in lead poisoning has moved from tertiary care of acutely lead poisoned children to secondary prevention of chronically lead poisoned children. Doctors who graduated decades ago may be accustomed to thinking of lead poisoning as an acute problem, may not be informed of, or may make light of the recent findings about how low-level lead poisoning is also dangerous. Doctors who graduated more recently may be more informed about recent lead poisoning research. Thus the study looked for a cohort effect in this data across time.

*d. Practice Type*

The fourth is variable of interest is practice type, of which the choices given in the survey were HMO, large group practice, solo/small

group practice, public hospital, private hospital, neighborhood health center, medical school and other. Different physicians practice under different rules and regulations and these differences in setting can influence physician behavior. One of the important factors that was suspected to influence lead screening behaviors was practice type. For example, an HMO may encourage universal screening, risk-based screening, or no screening through the effects of capitated payments to physician, utilization review, or the protocols it writes for well-child care. Another hypothesis is that groups that are profit-oriented may screen less than groups that operate out of charity or public funds, because chronic low level lead poisoning is unlikely to ever be picked up if the patients is not screened, and the long term costs of missed diagnosis are borne by the educational sector for the most part.

*e. Fee for Service Coverage*

The fifth predictor variable of interest was the percent of the practice that was covered by fee for service coverage. The proportion of patients covered by fee for service was asked of doctors in the survey with the possible responses being No, Few, About Half, Most and All.

This variable describes what proportion of patients from the doctor's primary practice are reimbursed through fee for service insurance mechanisms. Increased fee for service coverage can be hypothesized to be associated with increased screening. The medical profession has complained for years that the decrease in fee for service payments has resulted in decreased care for patients because HMOs and Medi-Cal restrict care and inadequately reimburse doctors for their services. Furthermore, some HMO's as a matter of policy discourage their doctors from screening patients, because the HMO administrators believe that lead screening is an inefficient use of

their resources.

Alternatively, increased fee for service coverage may be associated with decreased screening. First, fee for service coverage is more expensive than HMO coverage usually and thus a patient population with more patients covered by fee for service may be indicative that one's patients are wealthier, and that could result in less screening. Second, physicians who are reimbursed by fee for service mechanisms may be more independent of government or HMO regulation, and thus be freer to not do any screening if they so choose. Third, physicians may be trying to save money by doing less screening if lead screening is not adequately reimbursed by fee for service mechanisms. Fourth, as the proportion of children in a practice covered by fee for service insurance increases the proportion covered by CHDP should decrease. Since CHDP mandates that all CHDP children be screened for lead, it is reasonable to see some decrease in universal screening with increasing proportion of children reimbursed by fee for service mechanisms.

*f. HMO Coverage*

The sixth variable was the percent of the practice that was covered by an HMO. The proportion of patients covered by HMO health coverage was asked of doctors with the possible responses being No, Few, About Half, Most and All. HMO coverage may be hypothesized to have a positive or a negative association with lead screening. HMOs often claim to be giving better primary and preventative care. Lead screening should be part of this according to the CDC. On the other hand, chronic lead poisoning causes subtle (albeit important) problems and screening may not reduce HMO costs in the long-run. An HMO may find it uneconomical to screen for lead if it expects patients to change providers often or if subtle deficits will not be detected or



treated medically.

*g. Proportion of Practice that is General Primary Care for Children Under Age 6*

The seventh variable was the percent of the practice that was primary care pediatrics under six years old. This information was gathered by self-report in the survey. Within the specialties of pediatrics and family practice, different doctors spend different amounts of time providing primary care to young children. Some pediatricians may be doing more specialized care, and leave lead screening to their patient's primary care pediatrician. Some family physicians may have more older patients in their practices. Often physicians are most familiar with the problems and issues that affect their patients. Thus it may be reasonable to expect that physicians who spend a larger proportion of their time providing general primary care to young children may be more attune to children's needs, including the need for lead screening.

*Outcome Variables*

Outcome was measured in two ways. First, the physicians were asked about their screening approach to see if they are using a systematic approach to lead screening. Screening is the action of drawing blood to test the lead level in the blood. This variable is a measure of what system physicians use to decide whom to screen. Physician approaches to screening were coded three ways: universal, risk-based assessment and neither. Some physicians report universal screening, which is what the CDC recommended all physicians do in 1991. Universal screening should mean that the physician attempts to screen all young children. Another systematic form of screening would be risk-based assessment (RBA). Physicians who reported using CDC approved questions to determine whom to screen were classified as RBA.

RBA is what the CDC recommended in 1997. Those physicians who were not classified as Universal or RBA screeners were classified as Neither. This Neither category was a heterogeneous groups with some physicians doing no screening, others relying on observing symptoms to guide screening, others waiting for parents to ask for screening, and others using questions that the CDC does not approve for risk assessment.

This question about screening approach was analyzed in two ways

First, the universal screeners were compared to those who did not do universal screening to discover what factors differentiated universal screening physicians from others. Then, leaving out the universal screeners, the RBA screeners were compared to those who did Neither.

Second, all those who did either universal or RBA screening were compared to those who did neither. Then, leaving out those who did neither, the universal screeners were compared to the RBA screeners.

The second approach to understanding physician screening practices was look at the percent of children in the practice that the physician attempted to screen at ages 9-12 months, 13-24 months, 25-36 months, and 37-72 months. This information was provided by self-report on the survey. This question really gets to the crux of the lead poisoning problem. Physicians may perceive themselves as doing universal or RBA screening, but if they are not actually screening more children than other doctors, then they may not be screening adequately.

#### *Statistical Methods*

##### *STATA*

STATA (version 5.0) is a statistical package created by STATA Corporation. This program is user-friendly and powerful enough to do most of the analysis that this project required. The only function that STATA could not do that was needed was the chi square test for

trend, for which Epi-Info (version 6) was used.

The survey data set was obtained from the Duerr Resources. It was located in an Excel file and was loaded into STATA after appropriately recoding some of the variables so that they could be analyzed by STATA.

#### *Logistic Regression and Linear Regression*

Since part of the study was to explore the statistical significance, direction and magnitude of associations between variables, the tools of logistic and linear regression were used. Logistic regression was used for dichotomous outcome variables, and linear regression was used for continuous outcome variables. In logistic regression, the odds ratio is the measure of relative risk between the experimental group and the baseline group. In linear regression the coefficient of the predictor variable is the measure of the differences in risk between the experimental and the baseline groups. The p-values and confidence intervals associated with the odds ratios and coefficients of the regressions are statistics that measure the precision and statistical significance of the results. If the p-value is small, then the resulting odds ratio or coefficient is more likely to be statistically significant, in other words, to not be due to the random chance that is inherent in any survey in which a sample of the total population is expected to represent the total population.

Each logistic regression has a statistic called the pseudo R square and each linear regression has a statistic called the R square. These quantities are measures of what fraction of the variability in the outcome variable is explained by variability in the predictor variables. The larger the pseudo R square or the R square of a regression, the more predictive the predictor variables are of the outcome variable.

*Chi Square Test for Trend*

For ordered categorical variables, the chi square test for trend was used to evaluate whether there was a trend in odds that changed in a consistent way across categories. This test produces a list of odds ratios comparing the value of the outcome variable at each level of the predictor variable to the value of the outcome variable at the baseline of the predictor variable. Furthermore, it produces a p-value that reports if there is a significant trend across the groups. If the p-value is significant, then looking at the odds ratios can elucidate whether the trend is one of positive or negative association.

The results presented below are illustrated in tables in the appendix when indicated. All the results presented below are statistically significant unless otherwise stated. While some of the confidence intervals and standard deviations are presented here in the text, others can be found in the charts in the appendix. The more important findings will be revisited in the discussion section of this thesis.

**Chapter 3: Results***Overview*

Regarding the approach to screening, 29% of physicians reported using universal screening, 58% reported using risk-based screening, and 13% did neither. The mean amount of screening at ages 9-12 months, 13-24 months, 25-36 months, and 37-72 months were 27.4%, 27.8%, 19.1%, and 17.5% respectively with standard deviations (SD) of 40.3%, 38.6%, 33.2%, and 32.8% respectively.

The distribution of physicians in different practice types was 37% in solo or small group practices, 20% in large groups, 19% in HMO's, 3% in private hospitals, 5% in public hospitals, 7% in neighborhood health center, and 5% in medical schools.

**Pediatricians and Family Practitioners***Descriptive Statistics*

The survey showed that physician specialty was associated with a statistically significant difference in the percent of time that was spent giving general pediatric care to children less than 6 years old. Pediatricians reported spending on average 57.8% (SD 27.6) of their time giving general pediatric care to children less than 6 years old. On the other hand family practitioners reported spending on average 17.6% (SD 14.5) of their time with this patient population.

Pediatricians on average had 29.3% (SD 33.7) of their practice covered by CHDP, while family physicians reported an average of 20.0% (SD 29.7) of their practice being covered by CHDP. The linear regression gives a difference between the two populations being -9.3 (95% CI -14.4, -4.18).

Study physicians were asked several questions about their attitudes regarding childhood lead poisoning. These questions were scored on a 5 point scale with 5 being strongly agree, 3 being neither

agree nor disagree, and 1 being strongly disagree. Pediatricians felt more secure that their training gave them the skills needed to diagnose and treat lead poisoning. In response to the question, "My training gave me the skills necessary to diagnose and treat lead burdened patients," the mean score for pediatricians (3.4 (SD 0.98)) was statistically significantly higher than that for family physicians (2.9 (SD 1.1)). The coefficient of the difference between the two specialties was -0.52 (95% CI -0.67, -0.38). While this is not a very large difference, it points to a trend that pediatricians in general report themselves to feel more secure about their training regarding lead poisoning, while family physicians on average report feeling less secure about their training in this regard.

*Screening Approach, by Physician Specialty*

Pediatricians are more likely to do universal screening compared to other (RBA or neither RBA nor universal screening) than family physicians (OR 1.79, 95% CI 1.29, 2.49). (Appendix I, Page 58, Table 21) Among doctors who do not do universal screening, pediatricians are more likely than family physicians to do RBA compared to neither universal nor RBA screening (OR 2.75, 95% CI 1.93, 3.91).

The pseudo R<sup>2</sup>'s for these logistic regressions were both quite small (ranging from 1 to 5%). This implies that while these findings are statistically significant, there is much more variability that is not explained solely by this variable.

*Attempted Screening, by Physician Specialty*

Analysis of the percentages of patients that physicians reported attempting to screen at different ages showed that pediatricians on average attempted to screen 31% (SD 41%) and 32% (SD 40%) of their patients at ages 9-12 months and 13-24 months respectively. (Appendix I, Page 58, Table 22) On the other hand family practitioners screened

22% (SD 38%) and 21% (SD 35%) of patients at the same age groups. Contrasting the two groups we see that on average pediatricians screened 8.9% (95% CI 3.1, 14.7) more children at 9-12 months and 11.1% (95% CI 5.5%, 16.7%) more children at 13-24 months of age.

The pseudo R<sup>2</sup>'s for these linear regressions all are between 1 and 2% so there is a lot of variability in attempted screening that is not explained by physician specialty.

#### **Discrepancy between Ideal Screening and Attempted Screening**

In the survey physicians were asked both "What percentage of patients do you think should be screened?" and "What percentage of patients do you actually screen?" at different age groups. While the majority of doctors answered the same way for both questions at each age group, there was a difference between family practitioners and pediatricians. While family physicians and pediatricians on average both have similar ideas about what percentage of their children need lead screening, the discrepancy between "ideal screening" and "attempted screening" is 6.8% (95% CI 3.5%, 10.2%) greater at age 9-12 months and 4.5% (95% CI 0.5%, 8.4%) greater at age 13-24 months for family practitioners than pediatricians. (Appendix I, Page 59, Figure 1)

Looking at these results shows that pediatricians and family physicians are significantly different in their approaches to screening and the percentages of their child populations that they screen. For this reason the rest of the analyses have been done separating the pediatricians from the family physicians.

#### **I. Pediatricians**

##### **A. Screening Approaches, Pediatricians**

###### *1. Percent of Patients Covered by CHDP*

Pediatricians were divided into six groups according to the

percentage of their practice covered by CHDP. Compared to those with no CHDP insured patients, pediatricians with 41-60%, 61-80% or 81-100% of their patients insured by CHDP were significantly more likely to do universal, rather than other approaches to screening (either RBA or neither). The pseudo R2 for this regression with five degrees of freedom was 0.27, suggesting that percent of CHDP patients explains much of the total variability in lead screening approach.

When the pediatricians were divided into two groups according to the percentage of CHDP patients in the practice at the natural cut point of 40%, pediatricians with 41-100% CHDP patients are more likely to screen universally than those with 0-40% CHDP patients (OR 13.2, 95% CI 7.8, 22.1). (Appendix I, Page 48, Table 1) The pseudo R2 for this regression with one degree of freedom is 0.23, which indicates that this cut point of 40% allows us to reduce the degrees of freedoms without losing much predictive power.

Among the subset of pediatricians using either RBA or neither screening approach, percent of CHDP patients in their practice did not statistically significantly predict screening approach. When the pediatricians were divided into six groups according to CHDP percentage, only pediatricians with 61-80% CHDP eligible patients were significantly more likely to practice RBA compared to "neither" screening approach, a finding that just reached statistical significance ( $p=0.045$ ). The fact that the 81-100% group was not significantly different also suggests that CHDP is not a good predictor variable for the difference between pediatricians who screen using RBA and those using neither universal nor RBA screening. The pseudo R2 was only 0.037 further reinforcing this suspicion.

When the pediatricians were divided into two groups, the pediatricians with 41-100% CHDP patients were not significantly



different from the pediatricians with 0-40% CHDP patients with respect to the choice between RBA and neither, at the 0.05 level ( $p=0.054$ ). Thus RBA screeners and neither screeners do not have statistically significant differences with regard to CHDP.

Thus percent of CHDP patients in a practice is statistically significantly associated with universal screening and has strong predictive value for universal screening. However, CHDP is not associated with RBA screening for pediatricians.

### *2. Residency Graduation Year*

The pediatricians were split into two categories, those graduating from year 1950 to 1975 and those graduating from 1976 to 1995, according to the natural cut point noticed in the data during finer analyses around 1975. Pediatricians who graduated more recently when compared to those graduating earlier were more likely to use universal screening as opposed to others (either RBA or Neither) (OR 3.7, 95% CI 2.1, 6.6). (Appendix I, Page 48, Table 2) The pseudo R<sup>2</sup> for this regression is 0.04. Among those who did not do universal screening, pediatricians who graduated more recently when compared to those who graduated earlier were more likely to do RBA screening as opposed to neither universal nor RBA screening (OR 2.0, 95% CI 1.2, 3.4). The pseudo R<sup>2</sup> for this regression is 0.02.

### *3. Fee for Service Coverage*

As the proportion of fee for service patients in a practice increased pediatricians were significantly less likely to do universal relative to other forms of screening (RBA or neither). (Appendix I, Page 51, Table 7) There was no association between the proportion of patients with fee for service coverage and the ratio of RBA to neither. (Appendix I, Page 51, Table 8)

### *4. HMO Coverage*

For pediatricians there is no association between proportion of children covered by HMOs and overall screening (universal or RBA) as opposed to neither. (Appendix I, Page 54, Table 13) However among pediatricians who did either universal or RBA screening, an increasing proportion of patients with HMO coverage was strongly associated with decreased universal screening relative to RBA screening. (Appendix I, Page 54, Table 14)

**B. Attempted Screening, Pediatricians**

*1. Percent of Patients Covered by CHDP*

When pediatricians were divided into six groups according to the percentage of patients covered by CHDP in the practice, it was seen that all the pediatricians with 21-40%, 41-60%, 61-80% and 81-100% had significantly higher rates of screening at 9-12 months and 13-24 months than the baseline. On average, pediatricians with 0%, 1-20%, 21-40%, 41-60%, 61-80% and 81-100% CHDP patients reported screening 21%, 15.3%, 39.7%, 40.5%, 48.4%, and 58.3% of their patients at age 9-12 months respectively. On average, pediatricians with 0%, 1-20%, 21-40%, 41-60%, 61-80% and 81-100% CHDP patients reported screening 16.4%, 13.3%, 32%, 61.5%, 60.4%, and 65.7% of their patients at age 13-24 months respectively.

When divided into two groups pediatricians with 41-100% CHDP patients reported attempting to screen 50% of their patients at age 9-12 months while those with 0-40% CHDP patients reported screening 20% of their patients. (Appendix I, Page 49, Table 3) The difference between the low CHDP percentage group and the high CHDP percentage group at 9-12 months was 29.3 percentage points (95% CI 20.1, 37.8).

Pediatricians with 41-100% CHDP patients reported attempting to screen 63% of their patients at age 13-24 months while those with 0-40% only reported screening 17%. The difference between the low CHDP

percentage group and the high CHDP percentage group at 9-12 months was 45.9 percentage points (95% CI 38.4, 53.4). Thus percent of CHDP patients in a physician's practice has a strong positive association with attempted screening.

## *2. Residency Graduation Year*

Pediatricians who had graduated residency after 1976 on average reported screening 34.4% and 35.3% of their patients at ages 9-12 months and 13-24 month respectively. (Appendix I, Page 49, Table 4) Those whose who graduated before 1976 on average reported screening 16.2% and 20.7% of their patients at 9-12 months and 13-24 months. Pediatricians who graduated more recently screened 18.1 percentage points (95% CI 9.5, 26.9) more of their children at age 9-12 months and 15% (95% CI 5.9, 23.3) more of their children at 12-24 months than pediatricians who graduated earlier.

## **II. Family Physicians**

### **A. Screening Approaches**

#### *1. Percent of Patients Covered by CHDP*

The regressions that divided physicians into six categories according to the percent of patients covered by CHDP suggested that 20% might be a natural cut point for the data for family physicians as opposed to the 40% which was chosen for pediatricians. The data were thus recoded into two groups with the cut point at 20% for family physicians. The results using 20% as a cut point tended to have more significant p-values and larger pseudo R2 values than those for the cut point at 40%. Thus the 20% line is a good cut point for the dichotomization of this variable for family practitioners.

When the family physicians were divided into six groups according to CHDP percentage, the family physicians who had 41-60%, 61-80% or 81-100% of their patients covered by CHDP were significantly more likely

than the baseline group which had 0% CHDP patients to screen using universal screening rather than other (either RBA or Neither). The pseudo R2 for this regression was 0.16.

When the family physicians were divided into two groups according to CHDP percentage, those with CHDP populations from 21-100% were more likely to screen universally than those who were who had CHDP populations from 0-20% (OR 6.8, 95% CI 3.6, 12.9). The pseudo R2 for this regression was 0.13.

Among the subset of family physicians who were using RBA or neither screening approaches, only the family physicians who had 21-40% and 81-100% CHDP patients practiced statistically significantly more RBA screening relative to neither screening than the baseline group (0% CHDP patients). The pseudo R2 for this regression was a low 0.04. Thus this outcome variable is not well explained by CHDP percentage.

When the family physicians were divided into two groups according to percent of patients covered by CHDP, those with CHDP populations from 21-100% were more likely to screen using RBA than neither screening when compared to those who were who had CHDP populations from 0-20% (OR 2.8, 95% CI 1.3, 6.1). The pseudo R2 for this regression was only 0.03.

In summary the percent of patients covered by CHDP is statistically associated with both increased universal screening and RBA screening for family physicians. But the extent of the association and the predictive power of the association are stronger for universal screening, and weaker RBA screening.

## *2. Residency Graduation Year*

The family practitioners were also split into two categories, those graduation from year 1950 to 1975 and those graduating from 1976 to 1995, according to the natural break noticed in the data around

1975.

There was no statistically significant association between residency graduation year and universal screening as compared to other (either RBA or Neither). (Appendix I, Page 48, Table 2) However, when excluding the universal screeners from the analysis, more recent residency graduation year was associated with increased RBA screening compared to neither screening approach (OR 2.5, 95% CI 1.3, 4.8).

### *3. Fee for Service Coverage*

There is a strong association between increasing fee for service coverage and decreasing screening (either universal or RBA) relative to neither for family physicians. (Appendix I, Page 52, Table 9) None of the eight family physicians whose patients were all covered by fee for service did either universal or RBA screening. Among those who did screen, there was no association between proportion of patients covered by fee for service and the choice between universal and RBA screening. (Appendix I, Page 52, Table 10)

### *4. HMO Coverage*

There was no association between proportion of patients covered by HMOs and the ratio of screeners (universal or RBA) to non-screeners. (Appendix I, Page 56, Table 17) However, among screeners there was a significant association between increased HMO coverage and decreased universal screening relative to RBA screening. (Appendix I, Page 56, Table 18)

## ***B. Attempted Screening, Family Physicians***

### *1. Percent of Patients Covered by CHDP*

When the family physicians were divided into six groups according to CHDP percentage, the family physicians who had 21-40%, 41-60%, 61-80% or 81-100% of their patients covered by CHDP screened significantly more patients than the baseline group (0%) did. Those with 0%, 1-20%,

21-40%, 41-60%, 61-80%, and 81-100% of their patients covered by CHDP screened 13.5%, 15.6%, 45.9%, 40.4%, 48.9%, and 40.8% of their children at 9-12 months of age and screened 12.1%, 12.9%, 31.5%, 35.7%, 60.8%, and 51.7% of patients at 13-24 months.

When family physicians were dichotomized with 20% being the cut point, family physicians with higher levels of CHDP patients (21-100%) screened 43.7% and 44.2% of patients at 9-12 months and 13-24 months respectively. Those with lower levels of CHDP patients (0-40%) screen 14.6% and 12.5% respectively. The difference between the physicians with low and high proportions of CHDP patients in their populations was 29.1 percentage points (95% CI 19.0, 39.3) at 9-12 months and 31.7 percentage points (95% CI 22.6, 40.7) at 13-24 months.

#### *2. Residency Graduation Year*

In contrast to pediatricians, when the questions on attempted screening at 9-12 months and 13-24 months were regressed on this dichotomous residency graduation year variable, there was no significant difference between the younger and the older family practitioners.

### **III. Screening Approach and Attempted Screening**

The previous analyses concentrated on whether predictor variables, such as physician specialty, prevalence of CHDP patients in practice, and residency graduation year, had associations with approach to screening and attempted screening. Although it may seem reasonable to think that physicians who report screening universally should screen more than those who use some form of risk-based assessment (RBA), and that those who do RBA should be screening more than those who do neither universal nor RBA, these apparently self-evident assumptions should be scrutinized in light of the data. These analyses look at the question, "Are self-reported Universal Screening, RBA Screening and

Neither associated with any differences in attempted screening?"

**A. Attempted Screening, by Screening Approach, Pediatricians**

For pediatricians, in linear regressions with attempted screening at 9-12 months and 13-24 months being the outcome variables, the difference between RBA and neither screeners is just short of significant ( $p=0.052$ ) at 9-12 months, and is not significant ( $p=0.114$ ) at 13-24 months. The difference in attempted screening between universal and neither screeners is highly significant at both age groups.

On average the universal screeners reported screening 64.6% of their children at 9-12 months and 67.7% of their children at 13-24 months. The RBA screeners reported screening 16.1% of their children at 9-12 months and 16.2% of their children at 13-24 months. Those who did neither universal nor RBA reported screening on average 7.6% and 9.7% of their children. The difference between universal and neither is 57.1 percentage points (95% CI 47.9, 66.2) at 9-12 months. The difference between universal and neither is 58 percentage points (95% CI 49.3, 66.7) at 13-24 months. (Appendix I, Page 60, Figure 2)

**B. Attempted Screening, by Screening Approach, Family Physicians**

For family physicians, the differences between RBA and Neither and Universal and Neither are significant at both 9-12 months and 13-24 months.

On average the universal screeners reported screening 63.9% of their children at 9-12 months and 55.2% at 13-24 months. The RBA screeners reported screening 17.6% of their children at 9-12 and 17.1% of their children at 13-24 months. Those who did neither universal nor RBA reported screening on average 3.5% and 5.4% of their children. The difference between RBA and neither was 14.1 percentage points (95% CI 6.3, 22.0) at 9-12 months. The difference between RBA and neither is

11.8 percentage points (95% CI 4.3, 19.3) at 13-24 months. The difference between universal and neither is 60.5 percentage points (95% CI 51.1, 69.9) at 9-12 months. The difference between universal and neither is 49.9 percentage points (95% CI 41.0, 58.8) at 13-24 months. (Appendix I, Page 60, Table 3)

**Percent of Practice that is Primary Care Pediatrics less than 6 years old.**

When the logistic and linear regressions and chi square tests for trend were done there were no significant associations between the percent of practice that is primary care for children under 6 years old and any of the screening approach outcome variables.

**Practice Type**

As the data were analyzed, it appeared that the trends relating the practice type variable to the outcome variables were inconsistent. Many of the findings from certain practice type variables, especially medical school and public hospital were often insignificant due to small cell sizes. Furthermore, controlling for other variables, such as percentage of children covered by CHDP or year of residency graduation, often made certain variables significant and others insignificant without any reliable pattern.

Two methodological issues regarding this variable are small sample size and the potential for both differential and nondifferential misclassification. Some of the cell sizes for the less common practice types, (neighborhood health center, public hospital, private hospital, and medical school) make the calculations of odds ratios or regression coefficients unreliable.

Most importantly, any of these classifications could have overlapped with other ones. For example a physician at a public hospital of a medical school may work in a large group practice that



contracts with an HMO. Such a physician would be able to check any of four different practice types asked in the survey depending on how the question was understood. This lack of precision in defining the categories makes this variable an unreliable way of operationalizing the concept of variable practice type.

Often in a regression one of the nine practice type indicator variables would be significant, but usually only slightly significant with little predictive value (low R<sup>2</sup> or pseudo R<sup>2</sup>). Given that adding the practice type variable greatly increases the degrees of freedom in the model, and produces unreliable and small, marginally significant results, the practice type variable was not used for further analysis.

**Chapter 4: Discussion**

The results of this secondary data set analysis show that the variables physician specialty, percent of practice covered by CHDP, physician residency graduation year, percent of practice covered by fee for service coverage, and percent of practice covered by HMO coverage are statistically significant predictor variables of different lead screening practices.

*Physician Specialty*

The results of the survey reconfirmed some of the hypotheses about the differences between pediatricians and family physicians regarding training and patient population. In general, pediatricians felt more secure than family physicians that their training gave them skills for addressing the issue of lead poisoning.

The survey confirmed that pediatricians report more thorough lead screening efforts than family physicians. First, pediatricians are more likely to do universal screening than family physicians. Second, of the physicians who do not do universal screening, pediatricians are more likely than family physicians to do RBA than Neither. Also pediatricians on average reported screening 9% more children at 9-12 months and 13-24 months than family physicians did.

One of the interesting findings was that despite the fact that pediatricians and family physicians had similar ideals for what proportion of their patients need lead screening, individually pediatricians on average screened nine percentage points closer to their ideal levels of screening than family physicians. While this may be because of inaccurate reporting or response bias by the survey respondents, there is also a possibility that this is a sign that both pediatricians and family physicians have similar knowledge bases about the dangers of lead, but in their actions, pediatricians take the issue

more seriously than family physicians.

There are a number of possible explanations for this. First, the family physicians, who may look at patient problems from a "family" perspective may give relatively more value to problems other than lead poisoning. Second, family physicians may work in settings with fewer facilities for lead screening than pediatricians do. Third, this result could be a product of the differential response rate between pediatricians and family physicians.

These observations bring up the question of whether family physicians are concerned enough about the issue of lead poisoning. Lead poisoning is a family health issue because if one child is exposed to lead, chances are high that other members of the family and neighbors are also at risk.

Future intervention could be thus directed at educating family physicians about the importance of lead screening and at holding informational seminars about lead that target family physicians.

*Percent of Patients Covered by CHDP*

Of all the predictor variables, CHDP was the one that had the most predictive power (it produced the regressions with statistically significant results the highest R<sup>2</sup> and pseudo R<sup>2</sup> values). For both family physicians and pediatricians CHDP is strongly and statistically significantly associated with universal screening. Regressions that compared universal screening to others produced high odds ratios and pseudo R<sup>2</sup>. However, for pediatricians CHDP was not significantly associated with increased RBA screening when compared to Neither. For family physicians, CHDP was associated only weakly with increased RBA screening relative to Neither.

In theory, increased poverty should be associated with both increased universal screening and RBA screening relative to Neither,

because both these forms of screening should increase among physicians who work among children at higher risk for lead poisoning, such as poor children. One reason why universal screening may significantly increased in CHDP populations while RBA screening would not be significantly increased is the Matthews Vs Coye lawsuit in 1991, which forced all physicians to provide CHDP children with universal screening. Thus the findings suggest that the lawsuit in 1991 had an impact in forcing physicians of CHDP patients to do universal screening, and may have little or no impact on increasing RBA screening.

CHDP percentage is also significantly associated with increased attempted screening. This is reassuring because poor children are more likely to be at risk for lead poisoning than more wealthy children are. So at the least, while the current amount of screening is inadequate, at least it is being targeted more towards the populations that are more likely to be lead poisoned.

#### *Residency Graduation Year*

More recent residency graduation year is significantly associated with increased universal screening, increased RBA screening and increased attempted screening behavior for pediatricians. However, while the large odds ratios and coefficients indicate large group differences between younger and older physicians, the small pseudo R2 values indicate that this variable only is predictive of only a small part of the variability we see on the individual physician level.

Younger family physicians were just as likely to use universal screening as older family physicians. Among those who did not use universal screening, younger family physicians were more likely to use RBA screening rather than neither universal nor RBA screening. If taught correctly, RBA screeners should be screening more than those who

do neither RBA nor universal screening. However, despite this younger family practitioners do not screen statistically larger percentages of patients in the target age group than older family practitioners.

In summary this survey confirms the hypothesis that in general older physicians are not as compliant with the current CDC recommendations as younger physicians are. This may be attributable to changes in the way physicians were educated about the danger of lead poisoning over the past few decades. In the 1960's the main emphasis in lead poisoning intervention was the treatment of children who were acutely poisoned with high blood lead levels, which causes overt clinical symptoms. Currently, the main thrust of lead poisoning intervention is screening for chronic low level lead poisoning, which can cause damage to the child's nervous system silently. As the lead level of concern dropped over the years, physicians who were educated earlier may still be approaching lead screening looking for acute lead toxicity as an indication for screening, rather than screening apparently healthy children to prevent chronic lead poisoning.

Alternatively, perhaps all physicians coming out of medical school are more likely to screen patients. However, as physician's clinical experience accumulates over the years and as they interact with more older physicians who are against lead screening, they may come to see lead screening as less important than other parts of a well-child visit. While in some low-risk areas this may be a reasonable course of behavior, dropping lead screening out of the standard battery of tests for infants and toddlers increases the chances that a child can become lead poisoned at a critical age of development without being diagnosed.

#### *Fee for Service Coverage*

The larger the proportion of fee for service patients the

pediatrician has in his or her practice, the less likely he or she is to do universal screening. For family physicians increased fee for service coverage was associated with decreased universal and RBA screening. Two explanations for this are suggested.

First, fee for service physicians tend to be more independent than physicians who operate under the constraints of an HMO or Medical. These more independent physicians are more free to drop lead screening from the tests which they give to children and may do so to lower costs or to avoid the inconvenience of administering or recommending blood lead screening for the patient.

A second explanation for this finding is that physicians who have increased fee for service patients are serving more wealthy populations that are at lower risk for lead poisoning. If this is the case it may be reasonable for the physicians with higher fee for service coverage in their patient population to be doing less screening.

#### *HMO Coverage*

For both family physicians and pediatricians, increased HMO coverage in the practice was correlated with an increase in RBA screening and a decrease in universal screening, but was not correlated with a statistically significant change in the fraction of patients who are not screened by either method. Thus HMOs, contrary to their claims of providing better preventative and long-term care for patients, do not practice increased blood lead screening.

One reason for this may be the influence of physicians and businessmen who hold that lead screening is not a cost-efficient use of resources for an HMO. HMOs in general bring the costs of medical care to bear more heavily on the actions of their physicians. Some HMOs use utilization review and write protocols which physicians need to follow. If the protocol for a well-child calls for an RBA approach to lead

screening, but not universal screening, then that is what the HMO's physicians are going to do most of the time. Other HMOs use capitation reimbursement mechanisms to make physicians control costs, by taking the costs of care provided for a physician's patients directly out of each physician's income. In such a system, a physician who believes that lead poisoning screening is not very useful can easily rationalize not screening.

Another possible explanation is that patients who are covered by an HMO are less likely to be poor than patients who are not in an HMO are. This is because most people get their insurance coverage through their employers, and employed people are less likely to be poor than unemployed people are. The less poor patients there are in a practice, the less likely lead screening is going to be a major problem in the practice population. Thus less lead screening may need to be done if a physician's practice is largely well-to-do HMO patients.

#### *Attempted Screening by Screening Approach*

From the analysis of attempted screening by screening approach two important points arose. First even physicians who do universal screening screen on average less than 70% of children. Second, pediatricians who do RBA screening have attempted screening percentages that are statistically the same as pediatricians who do report doing neither universal or RBA screening.

There are a number of possible explanations for why self-described universal screeners may be screening so few of their patients. First, physicians may consider themselves universal screeners, despite not attempting to screen 100% of children at ages 9-12 months or 13-24 months if they screen children at older ages, instead of the appropriate younger ages. Second, physicians may have marked off that they "do universal testing" just to please the survey

directors by appearing to be in compliance with the CDC guidelines, despite writing down the actual percentages of patients that they attempt to screen later in the survey.

Regarding the observation that physicians who report themselves to be RBA screeners have attempted screening patterns that resemble the low screening pattern of those who report doing neither universal nor RBA screening, there are a number of possible reasons. First, perhaps some of the physicians who use RBA have excessively stringent criteria for considering a patient to be at high enough risk to justify lead screening. Second, perhaps RBA screeners do not assess risk for every patient, and thus only assess risk for a small group of patients and of that group only a few are screened. Third, perhaps claiming to do RBA is actually merely a way for physicians to ignore the problem of lead poisoning, while paying lip service to the importance of the problem.

Two variables that did not yield significant results were physician practice type and the percentage of the physician's practice that was primary care for children under 6 years of age.

#### *Strengths of the Study*

This study has the strengths of being a large randomly selected study. There being 821 respondents allowed the study to stratify the results into pediatricians and family physicians to examine the effects of residency graduation year, and proportion of patients covered by CHDP, fee for service coverage, or HMO coverage on the outcome variables independently of the effect of physician specialty.

Another advantage is that this study also had a high response rate of 71% of the eligible physicians responding, which is high for mail-in surveys. Furthermore, of the possible 7150 physicians in combined AAP/AAFP mailing lists, 1492 physicians were mailed surveys. Thus there is a high probability that the respondents were



representative of the target populations.

*Limitations of the Study*

First, one of the biggest weaknesses of this study is that it relies on physician self-report. There is a large potential for response bias. The respondents may answer the survey in a way that they think would please the researchers. In particular physicians may be tempted to overreport their attempted lead screening. A study that reviewed physician's patient records for lead tests would be more accurately able to analyze physician behavior. Unfortunately, to do such a study would be prohibitively expensive.

Second, such a survey relies on physician memory. Physicians may forget what they actually did and thus answer the questions inaccurately.

A third weakness of the study is that 29% of eligible respondents did not reply and there is no data about them. Thus one cannot tell if the nonrespondents differed from the respondents in any consistent way.

Fourth, even if a physician attempts to order a blood lead test to be done for the patient, there are other barriers to lead testing. Not all doctors offices have the ability to do blood lead tests, so the patient will often have to be referred off-site to have the test done. If a patient's caregivers do not have time to take the child to the lead testing site then the patient will not be screened. Thus physicians' reported attempted screening is probably higher than the actual amount of screening that patients receive.

**Chapter 5: Conclusions**

Despite great advances in the reduction in national average blood lead levels, there still remain significant numbers of children who are at risk for chronic lead poisoning. While many of the children with lead poisoning are concentrated in poor areas with decaying housing, children from all socio-economic strata are at risk. Furthermore, research through the 1980's showed conclusively that even low levels of blood lead, at least down to 10 mcg/dL are harmful for children's neurologic development.

This survey of pediatricians and family physicians in California illustrated a number of points that will be important in addressing the issue of lead poisoning in the future.

- Many children have never been screened for lead poisoning.
- Most physicians are not following the universal screening guidelines of the CDC in 1991.
- Most physicians who are not doing universal screening are open to using risk-based assessment (RBA) for determining who should be screened.
- Currently, physicians who report using RBA have screening patterns closer to those who do neither universal nor RBA screening than to those who do universal screening.
- Pediatricians are more likely to conduct universal screening than family physicians.
- Pediatricians attempted to screen more children than family physicians.
- Increased proportion of CHDP patients in a practice is associated with increased attempted screening and increased universal screening.

- Younger physicians have more thorough screening approaches than older physicians do.
- Physicians with practices with high percentages of patients with fee for service coverage are less likely to screen universally.
- Physicians with patient populations with high HMO coverage are less likely to screen universally and more likely to screen using RBA.

These findings lead to a number of directions for public policy and future research for the California Department of Health, Childhood Lead Poisoning Prevention Branch.

- The 1997 CDC guidelines need to be publicized since they represent a marked shift from the 1991 guidelines.
- Physicians need to be instructed about appropriate ways of doing RBA screening because the physicians who currently report using RBA screening practices do not screen much more than physicians who report using neither RBA nor universal screening.
- Target family physicians for outreach.
- Target older physicians for outreach.
- Engage in dialogue with HMOs to discuss how to apply the new CDC guidelines to their well-child care protocols.
- Future research could be directed towards what types of educational interventions are most effective in changing physician behaviors towards increasing lead screening.

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<sup>1</sup> **National Research Council**, *Measuring Lead Exposure in Infant, Children, and Other Sensitive Populations*, National Academy Press, Washington D.C., 1993, 24.

<sup>2</sup> **Murozumi, M., Chow, T. J., and Patterson, C.**, Chemical concentrations of pollutant lead aerosols terrestrial dusts and sea salts in Greenland and Antarctic snow strata, *Geochim. Cosmochim. Acta*, 33, 1247-1294, 1969.

<sup>3</sup> **National Research Council**, 24.

<sup>4</sup> **Needleman, H.**, *Human Lead Exposure*, CRC Press, Boca Raton, Florida, 1992, 26.

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- <sup>5</sup> National Research Council, 24.
- <sup>6</sup> Needleman, 31.
- <sup>7</sup> National Research Council, 5.
- <sup>8</sup> Centers for Disease Control and Prevention, *Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials*, CDC, Atlanta, 1997, 15.
- <sup>9</sup> Needleman, 26.
- <sup>10</sup> Ibid, 67.
- <sup>11</sup> Ibid, 31.
- <sup>12</sup> Ibid.
- <sup>13</sup> Ibid.
- <sup>14</sup> Ibid.
- <sup>15</sup> Needleman, 4.
- <sup>16</sup> Ibid.
- <sup>17</sup> Ibid, 90.
- <sup>18</sup> National Research Council, 3.
- <sup>19</sup> Centers for Disease Control and Prevention, *Preventing Lead Poisoning in Young Children*, CDC, Atlanta, 1991, 8.
- <sup>20</sup> Ibid.
- <sup>21</sup> Needleman, 229, 334.
- <sup>22</sup> Centers for Disease Control and Prevention, 1991, 9.
- <sup>23</sup> Needleman, 193.
- <sup>24</sup> Needleman, H.L., Schell, A., Bellinger, D., et al., The long term effects of exposure to low doses of lead in children: an 11-year follow-up report, *New England Journal of Medicine*, 322, 83, 1990.
- <sup>25</sup> Needleman, H., *Human Lead Exposure*, CRC Press, Boca Raton, Florida, 1992, 28.
- <sup>26</sup> NRC, 27.
- <sup>27</sup> Needleman, H., *Human Lead Exposure*, CRC Press, Boca Raton, Florida, 1992, 28.
- <sup>28</sup> Centers for Disease Control and Prevention, *Preventing Lead Poisoning in Young Children*, CDC, Atlanta, 1991, 7-9.
- <sup>29</sup> Needleman, H., *Human Lead Exposure*, CRC Press, Boca Raton, Florida, 1992, 192.
- <sup>30</sup> Centers for Disease Control and Prevention, *Screening Young Children for Lead Poisoning:*

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*Guidance for State and Local Public Health Officials*, CDC, Atlanta, 1997, v.

<sup>31</sup> **Brody, D., Pirkle, J.**, Blood Lead Levels in the US Population: Phase 1 of the Third National Health and Nutrition Examination Survey (NHANES III, 1998-1991), *JAMA*, 4, 272, 1994, 277.

<sup>32</sup> **Centers for Disease Control and Prevention**, *Preventing Lead Poisoning in Young Children*, CDC, Atlanta, 1991, 39.

<sup>33</sup> **Centers for Disease Control and Prevention**, *Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials*, CDC, Atlanta, 1997, 18.

<sup>34</sup> **Matthews Vs Coye**, United States District Court, Northern District of California, 1991.

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**Centers for Disease Control and Prevention,** Preventing Lead Poisoning in Young Children, CDC, Atlanta, 1991.

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## **Appendix I**

TABLE 1

Odds Ratios of Screening Approach in Practices Comprised of 41-100% CHDP Eligible Children Compared to Those Comprised of 40% or Below CHDP Eligible Children (the Baseline Comparison Group) by Specialty.

<i>SCREENING APPROACH COMPARISON</i>	<i>PEDIATRICIANS OR &amp; 95%CI</i>	<i>FAMILY PHYSICIANS OR &amp; 95%CI</i>
Screeners (Universal or RBA) vs Neither	7.6 (3.0, 19.5)	5.6 (2.3, 13.6)
Universal vs RBA	10.8 (6.3, 18.5)	6.2 (2.9, 13.0)
Universal vs Other (RBA or Neither)	13.2 (7.8, 22.1)	8.7 (4.4, 17.3)
RBA vs Neither	2.6 (0.98, 7.1)	2.5 (0.94, 6.7)

TABLE 2

Odds Ratios of Screening Approach of Physicians who Graduated from Residency in or after 1976 Compared to Those who Graduated from Residency from 1950 to 1975 (the Baseline Comparison Group) by Specialty.

<i>SCREENING APPROACH COMPARISON</i>	<i>PEDIATRICIANS OR &amp; 95%CI</i>	<i>FAMILY PHYSICIANS OR &amp; 95%CI</i>
Screeners (Universal or RBA) vs Neither	2.9 (1.7, 4.8)	2.4 (1.3, 4.3)
Universal vs RBA	3.1 (1.7, 5.6)	0.91 (0.39, 2.1)
Universal vs Other (RBA or Neither)	3.7 (2.1, 6.6)	1.5 (0.70, 3.1)
RBA vs Neither	2.0 (1.2, 3.4)	2.5 (1.3, 4.8)



TABLE 3  
 Attempted Screening by Percent of Patients Covered by CHDP among Pediatricians and Family Physicians

<i>PERCENT OF PATIENTS COVERED BY CHDP</i>	<i>PEDIATRICIANS ATTEMPTED SCREENING (SD)</i>	<i>FAMILY PHYSICIANS ATTEMPTED SCREENING (SD)</i>
	9-12 months	
0-40%	20.3% (35.2%)	17.7% (34.8%)
41-100%	49.6% (45.1%)	42.9% (45.1%)
	13-24 months	
0-40%	16.7% (29.7%)	14.4% (29.4%)
41-100%	62.6% (41.2%)	48.8% (41.6%)

TABLE 4  
 Attempted Screening by Residency Graduation Year among Pediatricians and Family Physicians

<i>RESIDENCY GRADUATION YEAR</i>	<i>PEDIATRICIANS ATTEMPTED SCREENING (SD)</i>	<i>FAMILY PHYSICIANS ATTEMPTED SCREENING (SD)</i>
	9-12 months	
1950-1975	16.2% (31.0%)	18.1% (37.6%)
1976+	34.4% (42.8%)	23.5% (38.5%)
	13-24 months	
1950-1975	20.7% (33.6%)	16.9% (34.1%)
1976+	35.3% (41.4%)	23.1% (35.5%)

TABLE 5

Odds Ratios for Screening Approach (Screeners [Universal or RBA] or Neither) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Pediatricians

<i>FEE FOR SERVICE</i>	<i>UNIVERSAL OR RBA</i>	<i>NEITHER</i>
No	51	6
Few	189	40
About Half	53	16
Most	20	7
All	2	1

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.56
About Half	0.39
Most	0.34
All	0.24

CHI SQUARE FOR LINEAR TREND: 4.860

P-VALUE: 0.02749

TABLE 6

Odds Ratios for Screening Approach (Universal or RBA) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Pediatricians

<i>FEE FOR SERVICE</i>	<i>UNIVERSAL</i>	<i>RBA</i>
No	26	25
Few	76	113
About Half	11	42
Most	9	11
All	0	2

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.65
About Half	0.25
Most	0.79
All	0.00

CHI SQUARE FOR LINEAR TREND: 5.245

P-VALUE: 0.02202

TABLE 7

Odds Ratios for Screening Approach (Universal or Other [RBA or Neither]) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Pediatricians

<i>FEE FOR SERVICE</i>	<i>UNIVERSAL</i>	<i>RBA OR NEITHER</i>
No	26	31
Few	76	153
About Half	11	58
Most	9	18
All	0	3

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.59
About Half	0.23
Most	0.60
All	0.00

CHI SQUARE FOR LINEAR TREND: 8.064

P-VALUE: 0.00451

TABLE 8

Odds Ratios for Screening Approach (RBA or Neither) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Pediatricians

<i>FEE FOR SERVICE</i>	<i>RBA</i>	<i>NEITHER</i>
No	25	6
Few	113	40
About Half	42	16
Most	11	7
All	2	1

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.68
About Half	0.63
Most	0.38
All	0.48

CHI SQUARE FOR LINEAR TREND: 1.861

P-VALUE: 0.17249

TABLE 9

Odds Ratios for Screening Approach (Screeners [Universal or RBA] or Neither) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Family Physicians

<i>FEE FOR SERVICE</i>	<i>UNIVERSAL OR RBA</i>	<i>NEITHER</i>
No	18	4
Few	98	43
About Half	42	31
Most	16	20
All	0	8

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.51
About Half	0.30
Most	0.18
All	0.00

CHI SQUARE FOR LINEAR TREND: 22.6  
P-VALUE:0.00000

TABLE 10

Odds Ratios for Screening Approach (Universal or RBA) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Family Physicians

<i>FEE FOR SERVICE</i>	<i>UNIVERSAL</i>	<i>RBA</i>
No	7	11
Few	36	62
About Half	15	27
Most	3	13
All	0	0

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.91
About Half	0.87
Most	0.36
All	--

CHI SQUARE FOR LINEAR TREND: 1.307  
P-VALUE: 0.25291

TABLE 11

Odds Ratios for Screening Approach (Universal or Other [RBA or Neither]) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Family Physicians

<i>FEE FOR SERVICE</i>	<i>UNIVERSAL</i>	<i>RBA OR NEITHER</i>
No	7	15
Few	36	105
About Half	15	58
Most	3	33
All	0	8

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.73
About Half	0.55
Most	0.19
All	0.00

CHI SQUARE FOR LINEAR TREND: 8.125

P-VALUE: 0.00436

TABLE 12

Odds Ratios for Screening Approach (RBA or Neither) by Proportion of Primary Practice Patients Covered by Fee for Service Coverage among Family Physicians

<i>FEE FOR SERVICE</i>	<i>RBA</i>	<i>NEITHER</i>
No	11	4
Few	62	43
About Half	27	31
Most	13	20
All	0	8

<i>FEE FOR SERVICE</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.52
About Half	0.32
Most	0.24
All	0.00

CHI SQUARE FOR LINEAR TREND: 14.4

P-VALUE: 0.00015

TABLE 13

Odds Ratios for Screening Approach (Screeners [Universal or RBA] or Neither) by Proportion of Primary Practice Patients Covered by HMO among Pediatricians

<i>HMO</i>	<i>UNIVERSAL OR RBA</i>	<i>NEITHER</i>
No	25	5
Few	88	14
About Half	102	26
Most	100	25
All	49	6

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	1.26
About Half	0.78
Most	0.80
All	1.63

CHI SQUARE FOR LINEAR TREND: 0.002

P-VALUE: 0.96502

TABLE 14

Odds Ratios for Screening Approach (Universal or RBA) by Proportion of Primary Practice Patients Covered by HMO among Pediatricians

<i>HMO</i>	<i>UNIVERSAL</i>	<i>RBA</i>
No	19	6
Few	54	34
About Half	29	73
Most	14	86
All	16	33

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.50
About Half	0.13
Most	0.05
All	0.15

CHI SQUARE FOR LINEAR TREND: 41.8

P-VALUE: 0.00000

TABLE 15

Odds Ratios for Screening Approach (Universal or Other [RBA or Neither]) by Proportion of Primary Practice Patients Covered by HMO among Pediatricians

<i>HMO</i>	<i>UNIVERSAL</i>	<i>RBA OR NEITHER</i>
No	19	11
Few	54	48
About Half	29	99
Most	14	111
All	16	39

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.65
About Half	0.17
Most	0.07
All	0.24

CHI SQUARE FOR LINEAR TREND: 39.475

P-VALUE: 0.00000

TABLE 16

Odds Ratios for Screening Approach (RBA or Neither) by Proportion of Primary Practice Patients Covered by HMO among Pediatricians

<i>HMO</i>	<i>RBA</i>	<i>NEITHER</i>
No	6	5
Few	34	14
About Half	73	26
Most	86	25
All	33	6

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	2.02
About Half	2.34
Most	2.87
All	4.58

CHI SQUARE FOR LINEAR TREND: 4.587

P-VALUE: 0.03221

TABLE 17

Odds Ratios for Screening Approach (Screeners [Universal or RBA] or Neither) by Proportion of Primary Practice Patients Covered by HMO among Family Physicians

<i>HMO</i>	<i>UNIVERSAL OR RBA</i>	<i>NEITHER</i>
No	10	11
Few	32	20
About Half	63	38
Most	58	35
All	27	10

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	1.76
About Half	1.82
Most	1.82
All	2.97

CHI SQUARE FOR LINEAR TREND: 2.445

P-VALUE: 0.11793

TABLE 18

Odds Ratios for Screening Approach (Universal or RBA) by Proportion of Primary Practice Patients Covered by HMO among Family Physicians

<i>HMO</i>	<i>UNIVERSAL</i>	<i>RBA</i>
No	6	4
Few	14	18
About Half	24	39
Most	13	45
All	8	19

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.52
About Half	0.41
Most	0.19
All	0.28

CHI SQUARE FOR LINEAR TREND: 6.198

P-VALUE: 0.01279



TABLE 19  
Odds Ratios for Screening Approach (Universal or Other [RBA or Neither]) by  
Proportion of Primary Practice Patients Covered by HMO among Family Physicians

<i>HMO</i>	<i>UNIVERSAL</i>	<i>RBA OR NEITHER</i>
No	6	15
Few	14	38
About Half	24	77
Most	13	80
All	8	29

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	0.92
About Half	0.78
Most	0.41
All	0.69

CHI SQUARE FOR LINEAR TREND: 2.622  
P-VALUE: 0.10538

TABLE 20  
Odds Ratios for Screening Approach (RBA or Neither) by Proportion of Primary Practice  
Patients Covered by HMO among Family Physicians

<i>HMO</i>	<i>RBA</i>	<i>NEITHER</i>
No	4	11
Few	18	20
About Half	39	38
Most	45	35
All	19	10

<i>HMO</i>	<i>ODDS RATIO (RELATIVE TO BASELINE)</i>
No	1.00
Few	2.47
About Half	2.82
Most	3.54
All	5.22

CHI SQUARE FOR LINEAR TREND: 6.067  
P-VALUE: 0.01377

TABLE 21

Odds Ratios of Screening Approach of Family Physicians Compared to Pediatricians (the Baseline Comparison Group).

<i>SCREENING APPROACH COMPARISON</i>	<i>OR &amp; 95%CI</i>
Screeners (Universal or RBA) vs Neither	0.33 (0.24, 0.47)
Universal vs RBA	0.80 (0.56, 1.1)
Universal vs Other (RBA or Neither)	0.56 (0.40, 0.77)
RBA vs Neither	0.36 (0.26, 0.52)

TABLE 22

Attempted Screening by Physician Specialty #

<i>PHYSICIAN SPECIALTY</i>	<i>ATTEMPTED SCREENING (SD)</i>
	9-12 months
Pediatricians	30.9% (41.3%)
Family Physicians	22.0% (38.0%)
	13-24 months
Pediatricians	32.2% (40.3%)
Family Physicians	21.1% (34.9%)

# The differences in mean reported levels of attempted screening between pediatricians and family physicians at 9-12 months and 13-24 months is significant at the 0.05 level.

Figure 1

Differences between physician responses to “what proportion of your patients in the age ranges listed below do you think should be tested for lead poisoning?” and “what proportion of your patients in the age ranges listed below do you attempt to test for lead poisoning?” by physician specialty.

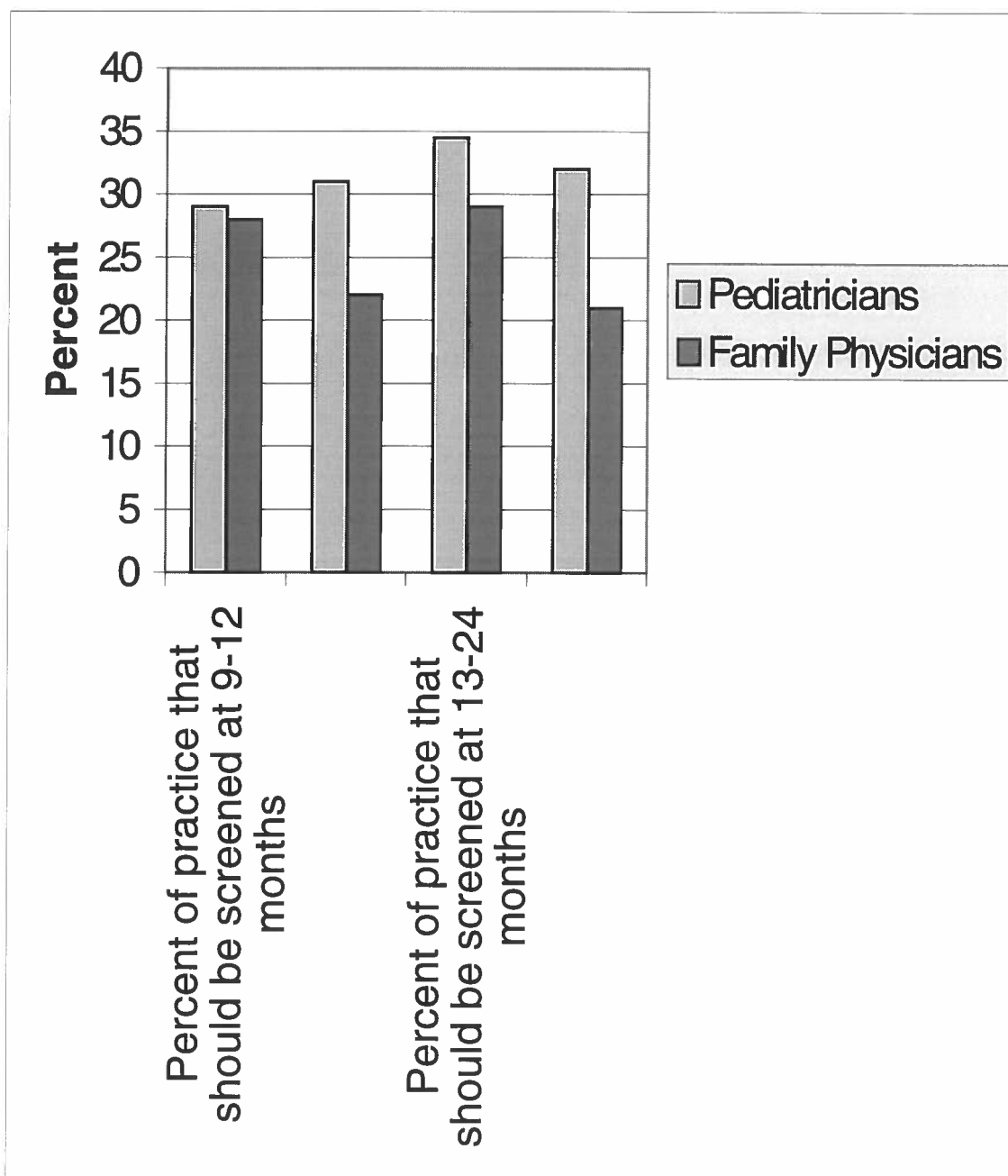


Figure 2  
The Association Between Screening Approach and Attempted Screening Among Pediatricians

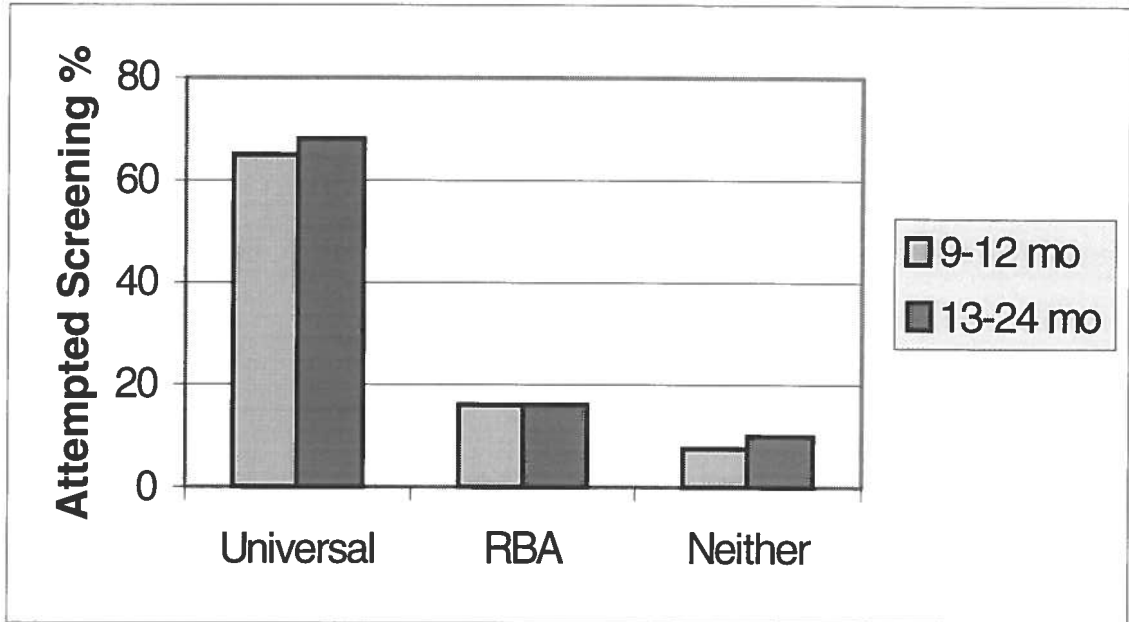
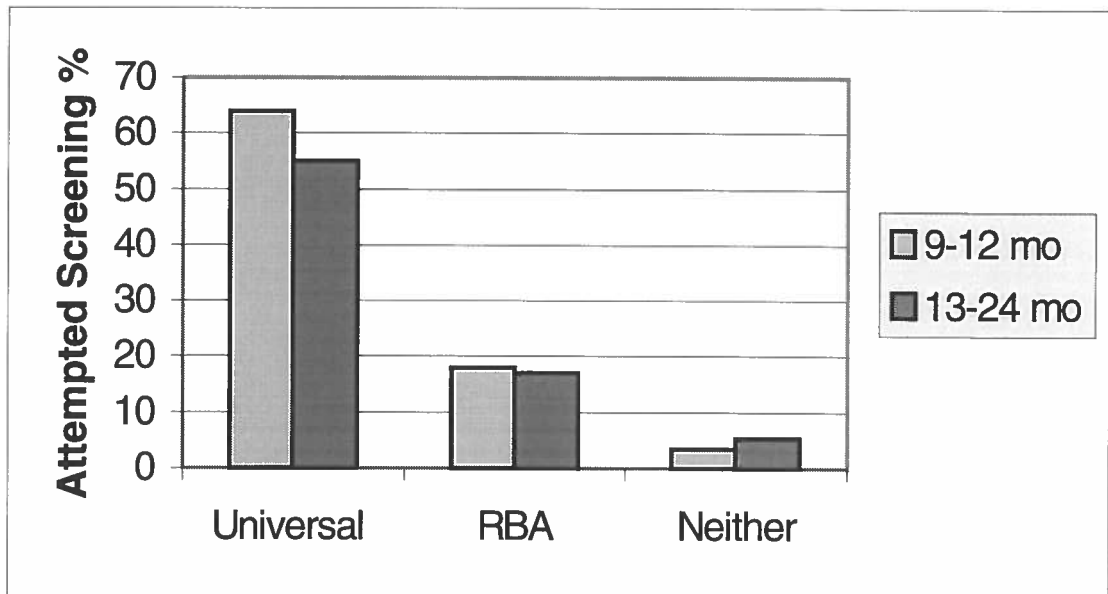


Figure 3  
The Association Between Screening Approach and Attempted Screening Among Family Physicians



## **Appendix II**

American  
Academy of  
Pediatrics



California District IX  
4690 Genesee Ave  
San Diego, CA 92117-3096  
619/569-5019  
Fax 619/569-0663

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619/569-5019

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Culver City, CA

President, Chapter 3  
Richard Walls, MD  
La Jolla, CA

President, Chapter 4  
Leonorah Stewart, MD  
Orange, CA

District Executive Director  
Kris Calvin, MA  
San Diego, CA  
619/569-5019

July 1995

Dear District Member:

The release of the 1991 U.S. Centers for Disease Control Statement on Childhood Lead Poisoning has generated substantial controversy regarding the role of pediatricians and the appropriateness of screening. To better understand your opinions, approach to screening and, most importantly, the difficulties you face identifying and managing children with lead poisoning in your practice, the California Department of Health Services has contracted with Duerr Evaluation Resources to conduct a survey of pediatricians about this issue. This survey is enclosed.

I strongly encourage you to take the time to complete this survey. This important survey provides a direct opportunity for you to express your opinions and needs to the California Department of Health Services and takes only a few minutes of your time. No one is better able to identify your needs and problems regarding childhood lead poisoning than you. The results of this survey will provide key information to DHS as it builds capacity throughout California to deal with this issue. Thank you for your time.

Sincerely,

Leonard A. Kutnik, MD  
Chair, District IX  
American Academy of Pediatrics

## THIRD MAILING

July 1995



CALIFORNIA  
ACADEMY OF  
FAMILY  
PHYSICIANS

Dear Doctor:

Re: Survey of Childhood Lead Poisoning Screening and Testing Practices

The California Academy of Family Physicians encourages your participation and support in a survey designed to determine the extent to which children in California are screened and tested for exposure to lead contaminants.

Both family physicians and pediatricians are being solicited for assistance on this matter, and it is important that family physicians' viewpoints be made known to the California Department of Health Services.

Your cooperation in completing this survey, and your suggestions about various barriers encountered to screening and testing for exposure to lead contaminants, as well as recommendations to help guide future efforts to develop more effective reporting systems are encouraged.

Thank you in advance for your assistance.

Sincerely,

A handwritten signature in black ink, appearing to read "Susan Hogeland". The signature is fluid and cursive, with a large loop at the end.

Susan Hogeland  
Executive Director

114 Sansome Street, Suite 1305  
San Francisco, CA 94104  
Tel 415 394 9121  
Fax 415 394 9119

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PHYSICIAN SURVEY  
page 1

### Survey Instructions

This survey is being sent to selected physicians who provide primary care to children throughout California. As you may be aware, when conducting a random sample survey it is critical to have a high response rate to be able to interpret data as representative for the entire population. As a result, it is very important that you, as a member of the sampled group, complete and return this questionnaire. In addition, it should be noted that the survey is completely confidential: no names or codes are contained on this form. However, to ensure a high response rate, we are planning extensive follow-up efforts with individuals not responding to this survey. We are asking that you separately mail the enclosed postcard. The return label on the postcard will then inform us that you have completed the survey which you have mailed under separate cover. This process will protect your anonymity since the postcard and survey are not linked in any way. Your identity cannot be tied to your completed questionnaire.

**PLEASE RETURN YOUR COMPLETED SURVEY AND POSTCARD BY  
SEPTEMBER 22, 1995.**

1. During a typical work week, what percentage of your time is spent providing general primary pediatric care to children less than six years (72 months) of age?
- 0% → see Note, below
  - 1%—25% → GO to Question 2, next page
  - 26%—50% → GO to Question 2, next page
  - 51%—75% → GO to Question 2, next page
  - 76%—99% → GO to Question 2, next page
  - 100% → GO to Question 2, next page

Note: This survey is intended for pediatricians and family physicians who currently provide general pediatric care to any children less than six years of age. If you checked "0%" to question 1, please answer question 1a. below and then return the survey and enclosed postcard so that you will be excluded from our survey sample and the associated follow-up efforts for non-respondents. Thank you.

- 1a. What is the primary reason that you do not provide general primary pediatric care for children less than six years of age? (✓ only one response)

- I am retired
- My patients are six years of age or older
- I am temporarily not in practice
- I work as a specialist (list specialty) \_\_\_\_\_
- I work in administration
- I teach at a medical school
- I am in fellowship training
- I am conducting research
- Other \_\_\_\_\_



PHYSICIAN SURVEY  
page 2

2. Have your practices regarding lead screening and/or testing changed in the last 24 months?  
 Yes       No → Go to Question 3

2a. In what ways have your practices changed? (✓ all that apply)

- Began screening/testing for lead poisoning
- Increased the frequency with which patients are screened/tested
- Increased the number of patients screened/tested
- Decreased the frequency with which patients are screened/tested
- Decreased the number of patients screened/tested

2b. What has influenced you to change your lead screening and/or testing practices? (✓ all that apply)

- Recent journal article
- Opinion of colleagues
- My own experience
- AAP recommendations
- CDC recommendations
- Local practice standards
- CHDP reimbursement
- Other (list): \_\_\_\_\_
- Recent lawsuits
- New legislation
- Media coverage
- Parental demand
- A local prevalence study
- CHDP guidelines
- Local health department workshops

3. What risk factors do you use to identify patients who may be lead burdened?

- I do not screen or test for lead exposure → Go to Question 4
- I order blood tests for all patients to determine blood lead levels → Go to Question 4

RISK FACTORS (✓ all that apply)

- ethnicity
- socioeconomic status
- urban residence
- peeling/chipping paint at residence
- peeling/chipping paint at other frequently visited locations
- rural residence
- age of residence
- friends or family being treated for lead poisoning
- lead-related employment or hobbies of household members
- use of pottery in food preparation
- use of folk home, or ethnic remedies
- location of residence (near known lead sources)
- parental request
- Other \_\_\_\_\_

4. In your opinion, what is the **lowest** blood lead level at which you would feel compelled to provide further medical evaluation? (✓ only one response)

- <math>\leq 9 \mu\text{g/dL}</math>
- 10-14  $\mu\text{g/dL}$
- 15-19  $\mu\text{g/dL}$
- 20-44  $\mu\text{g/dL}$
- 45-69  $\mu\text{g/dL}$
- $\geq 70 \mu\text{g/dL}$
- NO OPINION/DON'T KNOW

5. The California Department of Health Services is considering undertaking several activities to promote lead screening and testing of children by physicians. Please indicate your level of support for each activity by checking a rating.

ACTIVITY	LEVEL OF SUPPORT		
	Supportive	Neutral	Opposed
a. Provide written information to parents about lead poisoning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Conduct workshops or training sessions for physicians	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Develop and distribute written information to physicians regarding lead poisoning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Promote efforts to remediate lead from children's environments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Support conducting a local prevalence study in my community by testing all one-year-old children during a specified time period	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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For clarification, the term "SCREEN" refers to an assessment of risk for lead poisoning generally achieved through a line of questioning. The term "TEST" refers to the ordering or drawing of blood for analysis of lead level.

6. Several statements regarding lead poisoning screening and testing are listed below. Please respond to each statement by circling a rating which most closely reflects your opinion from the following scale.

RATING SCALE: 1= Strongly Disagree    2= Disagree    3= Neither Agree nor Disagree    4= Agree    5= Strongly Agree    DK= Don't Know

STATEMENT	1	2	3	4	5	DK
a. Lead exposure represents a significant health problem in my community.						DK
b. I believe it is possible to remediate lead in a child's environment to safe levels.						DK
c. Children with elevated blood lead levels are at high risk for cognitive impairment.						DK
d. I believe lead hazards can be identified by providing environmental follow-up on children with high blood lead levels.						DK
e. Lead poisoning is a major public health problem in the United States.						DK
f. Learning disabilities & decreased cognitive ability are manifestations of lead poisoning.						DK
g. Environmental lead exposure is a major cause of lead poisoning in children.						DK
h. My training gave me the skills necessary to diagnose and treat lead burdened patients.						DK
i. I believe that the CDC risk screening questions accurately assess risk for lead exposure.						DK
j. Children generally should not be screened with blood lead levels less than 70 µg/dL.						DK
k. I support universal blood lead testing.						DK
l. Lead poisoning is the primary cause of lead poisoning among children.						DK
m. I do not want to worry parents with the health effects of low level lead exposure.						DK
n. New medications are being used to treat lead poisoning at home.						DK
o. I believe that remediation of most childhood lead exposure sources is an unrealistic goal, given the resources required for identification and clean-up.						DK
p. I believe that early identification and testing for lead poisoning results in longer, well-child visits, resulting in higher overall patient satisfaction.						DK
q. I believe there is a very low incidence of lead poisoning in my community.						DK
r. I believe that environmental standards do not provide an effective treatment regime for lead poisoning in children.						DK
s. Children who do not display pica behavior are not at risk for lead poisoning.						DK
t. I believe that the current system of medical services and resources is adequate to address the problem of lead poisoning.						DK
u. I support universal screening for risk of lead exposure.						DK
v. I believe that lead & other environmental hazards are a major public health problem in my community.						DK
w. I believe that the medical community strongly recommends blood lead testing.						DK
x. I believe that the current blood lead testing standards are not sensitive enough to identify lead poisoning in my patients.						DK
y. Lead poisoning is a problem only for poor minority children.						DK
z. The system of managed care creates a disincentive to conduct blood lead testing.						DK

Question 7 asks what proportion of your patients should be tested based on your own opinion, free of published recommendations. Question 8 asks what proportion of patients in your office actually attempt to have tested. For both questions, assume complete appointment compliance and complete parental acceptance of testing. (Reminder: Testing is defined as the ordering or drawing of blood for analysis of lead levels.)

7. Approximately what proportion of your patients in the age ranges listed below do you think should be tested for lead poisoning? (If you think that none of your patients should be tested at a certain age group, enter a "0". Do not leave any of the spaces blank.)

Age 9-12 months \_\_\_\_\_ %

Age 13-24 months \_\_\_\_\_ %

Age 25-36 months \_\_\_\_\_ %

Age 37-72 months \_\_\_\_\_ %

8. Approximately what proportion of your patients in the age ranges listed below do you attempt to test for lead poisoning? (If you do not attempt to test any of your patients at a certain age group, enter a "0". Do not leave any of the spaces blank.)

Age 9-12 months \_\_\_\_\_ %

Age 13-24 months \_\_\_\_\_ %

Age 25-36 months \_\_\_\_\_ %

Age 37-72 months \_\_\_\_\_ %

9. Select the one response which most accurately describes how you determine if and when to test for lead poisoning.

I do not test or order tests → Go to Question 11

Only if patient is presenting symptoms

Based on my professional judgment

Only upon identified risk via screening completed by: →  Myself  Nurse  Parent  Other

All patients, but only at specific age(s): list age(s) in months \_\_\_\_\_

I do universal testing (9 to 72 months)

10. When you order blood lead tests, where is the blood drawn? (√ only one response)

In my office → 10a. What method is used?  Venipuncture  Fingertstick → Go to Question 11

At blood draw station at a location adjacent to or very near my practice → Go to Question 10b.

At a blood draw station at a different location from my practice → Go to Question 10b.

- 10b. What is the primary reason that you do not draw blood for lead testing in your office? (√ only one response)

Inadequate reimbursement to cover costs of additional equipment, hazardous material disposal, & time

Safety concerns regarding blood

No one in my office is adequately trained

Regulatory restrictions (i.e., CLIA, OSHA)

Other \_\_\_\_\_

11. Have you ever diagnosed and/or treated any of your patients with blood lead levels between:

	Yes	No
15-19 µg/dL?	<input type="checkbox"/>	<input type="checkbox"/>
20-44 µg/dL?	<input type="checkbox"/>	<input type="checkbox"/>
45+ µg/dL?	<input type="checkbox"/>	<input type="checkbox"/>

12. If an accurate and cost effective fingertstick test were to be developed, would you use it in your office for universal testing?

Yes  No

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13. Please select the best description of your primary practice type.
- Neighborhood health center     HMO     Solo or small group (≤4 physicians)  
 Private hospital     Public hospital     Medical School  
 Large group (≥5 physicians)     Other \_\_\_\_\_

14. Approximately how many of your patients from your primary practice maintain the following types of health care coverage? (Please make sure to check one and only one box for each type of coverage listed.)

TYPE OF COVERAGE	PATIENTS WITH COVERAGE				
	All	Most	About Half	Few	No
Fee for Service	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Managed Care Plan/HMO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Medi-Cal/CHDP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Do not know patients' types of health care coverage					

- 14a. Approximately what percentage of your pediatric patients are covered by CHDP? \_\_\_\_\_

15. What proportion of your patients would you estimate to be in the following ethnic or cultural groups? If you have no patients that you guess to be in a specific group, please place a zero (0) in that space. The total percentage should sum to 100%.

Native American or Alaskan Native .....	_____ %
Asian or Pacific Islander .....	_____ %
African American .....	_____ %
Hispanic .....	_____ %
White, non-Hispanic .....	_____ %
Other .....	_____ %
	100%

16. What is the five-digit zip code of your practice or facility? \_\_\_\_\_ (Note: This information is needed identify community demographic information from census data.)

17. What year did you finish residency? 19\_\_\_\_\_

18. Have you attended any trainings or workshops on lead poisoning in the past three years?

- No  
 Yes, please indicate the sponsor(s) of training(s) you attended from the list below:  
 AAP     Hospital     Local Health Department  
 University/Medical School     CA Dept. of Health Services     Other

19. Please identify your professional memberships. (✓ all that apply)

- AAP National     AAFP National     AMA     Co. Medical Society  
 AAP Local Chapter     AAFP County Chapter     CMA     Other

20. Which professional publications do you read regularly? (✓ all that apply)

- Pediatrics     AAP News     AJPH     Contemporary Pediatrics  
 JAMA     Local AAP News     NEJM     Western J. of Medicine  
 J. of Pediatrics     Archives of Pediatrics & Adol. Medicine     California Pediatrician

21. Which conferences have you attended in California in the past two years? (✓ all that apply)

- AAP State     AAFP State     AMA     Co. Medical Society  
 AAP Chapter     AAFP Co. Chapter     CMA     Hospital-based

22. Would you be interested in receiving CME credit for training regarding lead poisoning?  
 No (Go to Question 23)       Yes (Go to Question 22a.)

22a. Please indicate the training topic(s) and formats you would be most interested in receiving.

TRAINING FORMATS

Yes	No	TOPIC	IF Yes, select best Training Format →	Audio Tapes	Video Tapes	Workshops by Physicians	Workshops by Public Health Dept.
<input type="checkbox"/>	<input type="checkbox"/>	Drawing blood		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Environmental lead sources		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Parent education and counseling		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Nutritional intervention		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Lead remediation		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Public Health's role in case management		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Public Health's role in environmental follow-up		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

23. General Comments: \_\_\_\_\_  
 \_\_\_\_\_  
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**Thank you for completing the survey.**

Please be sure to mail the return postcard so you are not forgotten and time to follow-up with non-respondents.

If you misplace the self-addressed envelope, please mail to: Physician Survey, 55 Hanover Lane, Chico, CA 95973.