

Barriers to Lead Screening Among Pediatric Providers in King County, WA

Alexandra Perkins

A thesis

Submitted in partial fulfillment of the

Requirements for the degree of

Master of Public Health

University of Washington

2019

Committee:

Catherine Karr

Kristin Pace

Program Authorized to Offer Degree:

Department of Environmental and Occupational Health Sciences

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University of Washington

Abstract

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Alexandra Perkins

Chair of the Supervisory Committee:

Catherine Karr

Department of Environmental and Occupational Health Sciences

Pediatric care guidelines recommend assessment of children for lead exposure during routine child care in the first two years of life. In Washington State, pediatric lead screening rates are among the lowest in the nation. This investigation sought to describe pediatric lead screening practices and barriers in King County, WA. King County providers were invited to complete a web-based survey regarding their lead screening practices between October 2018 and April 2019. Follow up semi-structured interviews (SSI) were conducted with 13 volunteer respondents. Respondents were characterized as high versus low screeners based on responses. Reported knowledge, practice, and barriers were compared for the two groups. Grounded theory methodology was used to identify provider attitudes and practices from SSIs. 246 providers who saw patients under the age of 6 years participated in the survey. Sixty six percent agreed or strongly agreed with the statement “Primary care for all children aged 12 to 24 months in King

County should include a lead exposure history,” while only 39% reported always conducting a lead exposure history at least once during early childhood visits. Lower frequency screeners were more likely to report uncertainty about when to perform an exposure history and when to order a blood lead test. They were also more likely to report lack of a clinic system or policy to prompt them to conduct an exposure history. SSIs revealed a large variety in practices and barriers between clinics, suggesting that it will require a number of strategies to increase lead screening rates in King County. Strategies to improve lead screening rates in this community should include provider education on recommended screening practice, promoting standardized clinic policies, and working to partner with other early childhood development initiatives to promote lead screening, such as building collaborations with Early Head Start programs.

Background

Pediatric lead exposure has long been recognized as a potent neurodevelopmental toxicant. The United States federal government began regulating the use of lead in consumer products in the 1970s. As a result of increasing regulation in the subsequent decades, particularly around the use of lead in paint and gasoline, the incidence of elevated blood lead levels (EBLLs) in American children has been declining steadily.^{1,2} Over this same period, knowledge of the health risks of lead exposure has grown substantially. The blood lead level at which medical intervention is recommended has decreased from 60 $\mu\text{g}/\text{dL}$ in the 1960s to ≥ 5 $\mu\text{g}/\text{dL}$ today due to continuing research demonstrating adverse impacts at low levels. It should be noted that this reference blood lead concentration of ≥ 5 $\mu\text{g}/\text{dL}$ is “meaningful only for risk stratification,” and that there is truly no “safe” blood lead level.²

Young children (<6 years and especially <36 months) are particularly susceptible to lead poisoning as compared to older counterparts due to a developing blood-brain barrier, as well as age-appropriate behaviors such as crawling and mouthing. The most common risk factor for lead poisoning in pediatric populations in the United States is living in or regularly visiting homes built before 1978, when residential use of lead-based paints was banned. Other risk factors include: (1) living near a point source such as an airport, industrial zone, or historical orchard land, (2) contact with products containing lead that have been imported from other countries, (3) consumption of contaminated drinking water or contaminated soil, and (4) patients on Medicaid/from a low-income family.² Pediatric patients from economically disadvantaged backgrounds are disproportionately affected by lead poisoning because they are more likely to

live in older housing, and in communities with greater environmental contamination through the water and soil.^{3,4}

While national screening guidelines have been set by the American Academy of Pediatrics (AAP) and the Centers for Disease Control and Prevention (CDC), states have the ability to set their own testing protocols based on regional risk. Local guidelines are not always easily accessible or routinely followed. Thus, whether or not a child receives a blood lead test is commonly based on provider discretion. This variability in screening, paired with inadequate reporting of test results, make it difficult to know true pediatric lead poisoning prevalence. Estimates demonstrate that around 1.2 million children had an EBLL in the United States between 1999 to 2010, but that only half were reported. According to one study, Washington state had the lowest screening rate in the nation.⁵

Introduction

The negative health consequences of lead exposure in children are well documented. The Centers for Disease Control and Prevention (CDC) and the American Academy of Pediatrics (AAP) recommend public health interventions for children with blood lead levels above 5 ug/dL, though current evidence suggests that there are no safe blood lead levels.^{6,7} Lead toxicity is associated with significant neurocognitive and behavioral deficits in children, such as intellectual delay, attention difficulties, and lowered IQ scores.^{2,8,9,10,11,12,13,14}

Current CDC lead screening guidelines for pediatric patients recommend universal screening for those at high risk, including those who live in communities with over 27% of housing built before 1950 or a high prevalence (>12%) of elevated blood lead levels (≥ 10 ug/dL) in children aged 12 to 36 months in the community.¹⁵ Federal law requires that all Medicaid patients receive blood lead testing at 12 and 24 months of age. Beyond this, states and cities are advised to set their own lead screening policies based on regional variation in risk.²

In Washington state, it was estimated that fewer than 2% of the expected pediatric elevated blood lead level (EBLL) cases were reported to the CDC between 1999 to 2010.⁵ Washington state had one of the lowest reported-to-predicted EBLL case counts in the nation over this time period.⁵ The Washington State Department of Health convened an Expert Panel to come up with explicit guidelines for targeted lead screening for the first time in 2015, in an effort to increase state screening rates.¹⁶

Nationally, the legacy of lead based paint remains an important source of lead exposure for children. The Washington State Department of Health estimates that roughly 36% of houses in King County were built before 1980, and thus pose risk of lead exposure via paint in residential dust or soil.¹⁷ Recent immigration/refugee status is another risk factor for exposure. Refugee children are supposed to be lead screened upon arrival in the United States. According to the Department of Health, refugee children had positive blood lead tests at a rate of 16.7% in the second half of 2012, compared to 3.4% in non-refugee children.¹⁶ Industrial activity, such as contamination from the plume originating from a smelter near Tacoma, WA, has also caused exposures locally.¹⁸

Research on barriers to screening is crucial, given the long term health consequences of EBLs for children and the preventability of these outcomes. This study sought to address the gap between lead screening practices and screening guidelines in King County through provider surveys, as well as through semi-structured interviews. We attempted to identify barriers through investigation of provider knowledge around lead exposure and screening guidelines, attitudes on lead risk in King County, and their reported practices around lead screening.

Methods

A web-based, 10-minute anonymous survey was created and distributed to King County pediatric providers from November 2018-April 2019. Subsequently, semi-structured interviews were conducted with a subset of survey participants who indicated interest. The survey was administered through the website [surveymonkey.com](https://www.surveymonkey.com). Responding providers who met the

following criteria were included in this investigation: (a) worked in King County, and (b) were actively seeing patients under the age of six.

Recruitment for survey participation began with identifying the approximately 1,200-1,500 providers in King County who see pediatric patients, followed by securing endorsements from professional organizations and thus referencing their logos and support in all communications. An effort was made to reach family medicine and pediatric doctors, naturopathic doctors, osteopathic doctors, nurse practitioners, and physician assistants. Organizations and clinics distributed the survey over list serves. Further participation was sought through reaching out to personal connections and cold calling.

The initial survey instrument was drafted by health professionals at Public Health Seattle & King County (PHSKC), and input was solicited from other team members at PHSKC and the University of Washington, as well as four providers in the community. The final survey instrument contained 22 questions, including multiple choice and Likert scale questions, with several areas for free response. Survey content focused on provider knowledge, and typical practices around lead screening, as well as current barriers to taking lead exposure histories and checking blood lead levels. Eight individuals, including five healthcare providers, pre-tested the survey, which was then revised based on feedback and pretest results. The study was reviewed by the University of Washington Institutional Review Board and was deemed exempt.

Descriptive analysis of responses pertaining to typical practices around assessing lead exposure, barriers to screening, and participant demographic data were performed. Participants were split

into “Higher” and “Lower” screening groups based on their responses to the question, “What is your typical practice for assessing your patient’s lead exposure risk through exposure history questions?” The higher screening group consisted of participants who responded that they always or sometimes conducted a lead exposure history at least once during their patients’ early childhood visits (age < 3 years). Seven participants responded that they did not conduct exposure histories because they do universal blood lead testing, and were also counted in the higher screening group. Some participants answered that they sometimes conduct lead exposure histories, and that they conduct on parental request. These participants were counted in the higher screening group. The lower screening group consisted of participants who responded that they conduct lead exposure histories for this age group only upon parental request, or not at all. High versus low screening group responses were compared using chi squared tests for yes/no responses and Wilcoxon-Mann-Whitney tests to compare Likert distributions. Statistical analysis was performed using R statistical software.

13 semi-structured telephone interviews (SSIs) were conducted with providers who indicated interest after taking the survey. Interviews were conducted between February and April of 2019. Interviewees were selected from a set of 44 providers showing interest, based on clinic location, so as to include a wide range of clinics and patient populations served. Each interview lasted approximately 20 minutes. In these interviews, there was one interviewer and one interviewee. The conversation was recorded and transcribed by the interviewer.

An interview guide consisting of 14 questions was developed by a team of medical and public health specialists, including one pediatrician. Questions covered knowledge of lead exposure

risks and medical management as well as barriers to screening and strategies to overcome these barriers.

SSI data was analyzed using a team-based inductive approach. Grounded theory was used to formulate concepts. Interview questions and transcripts were read through to develop a coding scheme. Transcripts were then reviewed multiple times by two authors (A.P. and M.E.), and the coding scheme was continually revised to allow for emergence of more specific themes. Each author coded transcripts independently. Differences in coding were resolved through in-depth discussion to reach consensus.

Results

Provider survey

319 medical providers responded to the survey. Of these, 246 providers indicated that they regularly saw patients under the age of 6 years. Only 39% of all providers reported taking a lead exposure history at least once during early childhood visits. Participants reported conducting exposure histories occasionally (25%) or upon parental request (24%), while 10% reported never conducting one. Thirty percent of all respondents reported not knowing what the lead exposure risks are in King County. Fifteen percent reported not knowing when to perform an exposure history or order a blood lead test. Seventeen percent indicated caregiver refusal or discomfort at a lead test recommendation (Table 5).

157 providers met the definition for the higher screening group and 62 were included in the lower screening group. The remaining 27 providers who indicated they saw children under 6

years did not respond to the screening question and were not included in group-based analysis.

Demographic characteristics can be seen in Table 1. The large majority were MDs. Among the naturopathic respondents, all met the high screener category. However, there were only 14 naturopathic participants in the survey.

Table 1: Provider Survey Participant Profession and Practice Characteristics

	Total, n=246	HS*, n=157	LS*, n=62	P-value
	(%)	(%)	(%)	
Profession				
ARNP	12 (5)	7 (4)	5 (8)	0.47**
DO	4 (2)	2 (1)	2 (3)	0.68
MD	183 (74)	125 (80)	51 (82)	0.80
ND	14 (6)	13 (8)	0 (0)	0.04**
PA	5 (2)	2 (1)	3 (5)	0.28**
Other	1 (0)	1 (0)	0 (0)	
Missing Response	27 (11)	7 (4)	1 (2)	
Specialty				
Family Medicine	91 (37)	63 (40)	27 (44)	0.76
Pediatrics	121 (49)	85 (54)	29 (47)	0.40
Other	6 (2)	1 (0)	5 (8)	
Missing Response	28 (11)	8 (5)	1 (2)	
Estimated Percentage of Patients 0-6yrs on Medicaid insurance				
0-25%	77 (31)	49 (31)	28 (45)	0.07
26-50%	33 (13)	23 (15)	6 (10)	0.45
51-75%	27 (11)	20 (13)	6 (10)	0.69
76-100%	62 (25)	42 (27)	17 (27)	1.0
I don't know	19 (8)	17 (11)	2 (3)	0.13
Missing Response	28 (11)	6 (4)	3 (5)	

*High screening group (HS); low screening group (LS)

**Small screening group

Responses reflecting attitudes and beliefs are included in Table 2. There was a statistically significant difference in the distribution of agreement/disagreement to the statements: (a)

“Primary care for all children aged 12 to 24 months in King County should include a lead exposure history,” and (b) “My pediatric patients are at risk for lead poisoning.” Providers in the lower screening group were more likely than their counterparts to disagree/strongly disagree with both statements. Answers to a third question asking about provider agreement with testing all children before the age of two were not statistically significant.

Table 2: Provider Attitudes and Beliefs on Lead Assessment in Pediatric Care

Agreement with the statement:	Total, n=246 (%)	HS, n=157 (%)	LS, n=62 (%)	P-value*
<i>Primary care for all children aged 12 to 24 months in King County should include a lead exposure history</i>				
1. Strongly Disagree	2 (1)	1 (0)	1 (2)	
2. Disagree	13 (5)	1 (0)	12 (19)	
3. Neutral	39 (16)	19 (12)	20 (32)	<0.01
4. Agree	94 (38)	72 (46)	22 (35)	
5. Strongly Agree	70 (28)	63 (40)	7 (11)	
6. NA (blanks)	28 (11)	1 (0)	0 (0)	
<i>All children in King County should be tested for blood lead levels before the age of two</i>				
1. Strongly Disagree	21 (9)	13 (8)	8 (13)	
2. Disagree	67 (27)	45 (29)	22 (35)	
3. Neutral	48 (20)	34 (22)	14 (23)	0.08
4. Agree	55 (22)	42 (27)	13 (21)	
5. Strongly Agree	27 (11)	22 (14)	5 (8)	
6. NA (blanks)	28 (11)	1 (0)	0 (0)	
<i>My pediatric patients are at risk for lead poisoning</i>				
1. Strongly Disagree	9 (4)	2 (1)	7 (11)	
2. Disagree	51 (21)	31 (20)	20 (32)	
3. Neutral	56 (23)	41 (26)	15 (24)	
4. Agree	84 (34)	66 (42)	18 (29)	< 0.01
5. Strongly Agree	17 (7)	15 (10)	2 (3)	
6. NA (blanks)	29 (12)	2 (1)	0 (0)	

*Wilcoxon-Mann-Whitney test for distribution; p-value refers to distribution of responses, not individual answer choices

Regarding knowledge of lead screening guidelines, providers reported awareness of AAP/Bright Futures guidelines most frequently of all of the lead screening guidelines (44%), followed by Medicaid guidelines (24%). Providers in the higher screening group were more likely to be aware of the AAP/Bright Futures guidelines (HS 55%, LS 34%, $p=0.01$), as well as the Washington Department of Health guidelines (HS 25%, LS 10%, $p=0.02$) (Table 3). Overall, providers reported accessing information to inform clinical practice from online clinical resources (57%), colleagues (53%), and peer-reviewed journals (53%) most frequently. High screeners 69% were more likely than low screeners 48% to access information from online clinical resources ($p < 0.01$), whereas low screeners were more likely to access information from staff meetings (HS 20%, LS 39%, $p=(0.01)$) (Table 4).

Table 3: Provider Awareness of Guidelines on Pediatric Lead Screening

	Total, n=246 (%)	HS, n=157 (%)	LS, n=62 (%)	P-value
Which guidelines/requirements are you aware of?				
1. AAP/Bright Futures	108 (44)	87 (55)	21 (34)	<i>0.01</i>
2. Medicaid	58 (24)	46 (29)	12 (19)	0.18
3. WA DOH	46 (19)	40 (25)	6 (10)	<i>0.02</i>
4. CDC	41 (17)	30 (19)	11 (18)	0.97
5. PH Seattle King County	31 (13)	24 (15)	7 (11)	0.58
6. AAFP	28 (11)	19 (12)	9 (15)	0.80
7. US PH Taskforce	15 (6)	13 (8)	2 (3)	0.30*
8. WA Poison Center	5 (2)	5 (3)	0 (0)	0.36*
9. Other	5 (2)	5 (3)	0 (0)	0.36*
10. NA (blanks)	95 (39)	40 (25)	28 (45)	

*Small sample size

Table 4: Provider Self-Reported Sources of Information for Clinical Practice

	Total, n=246 (%)	HS, n=157 (%)	LS, n=62 (%)	P-value
Where do you typically access education and information to inform your clinical practices**?				
1. Staff meetings	56 (23)	32 (20)	24 (39)	0.01
2. In person professional conferences/CME courses	107 (43)	76 (48)	31 (50)	0.95
3. Grand Rounds	39 (16)	28 (18)	11 (18)	1.0
4. Peer-reviewed journals, including published practice guidelines	131 (53)	97 (62)	34 (55)	0.43
5. Colleagues	130 (53)	95 (61)	35 (56)	0.69
6. Online clinical resources	139 (57)	109 (69)	30 (48)	<0.01
7. Online continuing medical education courses	82 (33)	62 (39)	20 (32)	0.40
8. Newsletters from medical organizations	64 (26)	41 (26)	23 (37)	0.15
9. State or local health department website/personnel	76 (31)	54 (34)	22 (35)	1.0
10. Other	4 (2)	3 (2)	1 (2)	1.0*
11. NA (blanks)	31 (13)	3 (2)	1 (2)	

*Small sample size

**Respondents could select up to three answer choices

Questions regarding clinical practice and barriers to screening are shown in Table 5. The first topic, “Typical practice for assessing lead exposure risk through exposure history questions,” was used as the basis to create higher versus lower screening groups. Regarding challenges faced when deciding whether to conduct an exposure history, lower screeners were more likely to report uncertainty as to when to perform an exposure history (HS 9%, LS 37%, $p < 0.01$) and when to order a blood lead test (HS 13%, LS 29%, $p < 0.01$) than their counterparts. They were also more likely to report lack of a clinic system or policy to prompt them to conduct an

exposure history (HS 27%, LS 52%, $p < 0.01$). Higher screeners were more likely to report experiencing no challenges in taking exposure histories (HS 40%, LS 21%, $p = 0.01$). There were no statistically significant differences between higher versus lower screening group responses regarding lack of time to conduct exposure histories, lack of knowledge on lead exposure risks or next steps if results are positive, caregiver refusal to have blood test performed, or the necessity for patients to travel off-site to have blood tests performed. No statistical difference in responses between groups was found when asking about financial reimbursement for blood lead tests, but the sample size was small.

Table 5: King County Provider Report of Lead Assessment Practices and Challenges

	Total, n=246 (%)	HS, n=157 (%)	LS, n=62 (%)	P-value
Typical practice for assessing lead exposure risk through exposure history questions **, ***				
1. I always conduct a lead exposure history at least once during my patient's early childhood visits	95 (39)	95 (61)	0 (0)	Na
2. I sometimes conduct a lead exposure history at least once during my patient's early childhood visits	62 (25)	62 (39)	0 (0)	Na
3. I conduct a lead exposure history if my patient's caregivers have questions or concerns about lead exposure	60 (24)	24 (15)	36 (58)	Na
4. I do not conduct lead exposure histories	25 (10)	0 (0)	25 (40)	Na
5. Other *(if they responded that they always do BLLs as a clinic policy and thus don't take exposure histories, I counted that as "1")	5 (2)	1 (0)	4 (6)	Na
6. NA (blanks)	27 (11)	0 (0)	0 (0)	

Challenges faced when deciding to assess for lead exposure through an exposure history **				
1. I am not sure when I should conduct a lead exposure history	37 (15)	14 (9)	23 (37)	<0.01
2. I don't have time to conduct a lead exposure history in routine pediatric visits	42 (17)	25 (16)	17 (27)	0.08
3. There is no clinic system or policy in place to prompt me to conduct a lead exposure history	75 (30)	43 (27)	32 (52)	<0.01
4. I don't know what lead exposure risks are relevant in King County	73 (30)	49 (31)	24 (39)	0.37
5. I don't know the next steps to take based on results of a lead exposure history	18 (7)	13 (8)	5 (8)	1.0
6. I don't experience any challenges in conducting a lead exposure history	76 (31)	63 (40)	13 (21)	0.01
0. Other	27 (11)	21 (13)	6 (10)	0.60
7. NA (blanks)	31 (13)	3 (2)	1 (2)	
Challenges faced when deciding to order a blood lead test**				
1. I am not sure when a blood lead test is indicated	38 (15)	20 (13)	18 (29)	<0.01
2. Patient must go to another facility for the blood sample for the blood lead test	25 (10)	18 (11)	7 (11)	1.0
3. I am not comfortable interpreting blood lead test results	8 (3)	5 (3)	3 (5)	0.85
4. Caregivers refuse or are uncomfortable when I recommend blood testing for lead.	41 (17)	33 (21)	8 (13)	0.23
5. I am unsure how to follow up with an elevated blood lead test result.	27 (11)	17 (11)	10 (16)	0.40
6. There is inadequate financial reimbursement for blood lead lab tests.	9 (4)	9 (6)	0 (0)	0.12*

7. It is difficult to obtain reimbursement for blood lead lab tests.	7 (3)	7 (4)	0 (0)	0.21*
8. I do not experience any challenges that affect ordering blood lead tests.	109 (44)	79 (50)	30 (48)	0.91
0. Other	34 (14)	24 (15)	10 (16)	1.0
9. NA (blanks)	29 (12)	2 (1)	0 (0)	

*Small sample size

** Total responses are above the total number of participants because participants could select multiple answers

*** P-values are listed as “na” because screening groups were based on participants’ response to this question

Semi structured interview

Provider Demographics

Of the 13 providers interviewed, 4 (31%) practiced in clinics with over 50% of their patients on Medicaid. Three (23%) were in clinics with 20-40% of patients on Medicaid, and 6 (46%) had a patient population with a minority on Medicaid (<10%). Providers were predominantly MDs (92%), and had been practicing for a range of 2 to 35 years. All providers were trained in the United States.

Responses to Questions related to Knowledge and Perspectives on Practice

All providers except for one responded that they felt comfortable discussing the negative health impacts of lead exposure in children. Six were able to name Medicaid testing requirements specifically; the remainder were either unsure or were not asked during the interview. Every provider was aware that old housing was a risk factor for lead exposure due to paint containing lead. Other commonly mentioned risk factors included industrial exposures/parent occupational exposures, imported products, and lead in the soil. Five (38%) also mentioned that they would

check a blood lead level during workup of developmental delay. One doctor even said that she tended to only perform lead screening in the case of developmental delay, unless the parents brought up specific concerns.

Providers completed medical training, including medical school and residency, across the country. Those who trained and/or practiced elsewhere reported screening more in their previous place of practice as compared with Seattle. A provider stated: “I did my training in Philadelphia, and there we screened everyone for lead risk between 9 and 15 or 18 months. Since I’ve been [in Seattle], I have screened very, very few children for lead and that’s kind of a practice that our whole group has used, mostly led by information from [other providers].” Amongst those who trained locally, there was also a perception that lead screening was not highlighted in medical training. One provider noted: “It’s sort of a weird quirk of the training locally, is that [lead screening] seemed kind of deemphasized when I trained here ten years ago ...I think that it’s not at the forefront of providers’ minds here.”

Of the providers who were asked about the prevalence of lead poisoning in their patient populations, all reported low numbers of cases. This was true in clinics with the majority of patients on private insurance as well as in clinics with nearly all patients on Medicaid. Further, clinics with both high and low screening rates reported a low prevalence of lead poisoning. An experienced provider commented, “I initially screened patients, and I still do, but really never found an elevated lead level in 35 years of practice.”

Responses to Questions related to Screening Practices and Barriers to Screening

There was a wide variety of screening practices between clinics, even amongst clinics seeing patients of similar demographics. Even amongst clinics with an over 50% Medicaid patient population, some had no screening practices while others were attempting to get a blood test from every child on Medicaid. Commonly mentioned reasons for screening included identification of old housing, developmental delay, and upon parent request. All providers who were asked stated that performing an exposure history took under five minutes.

Barriers to screening varied between providers. The most commonly cited barrier was confusion as to the actual prevalence of lead poisoning in King County. This contributed to providers' uncertainty as to the efficacy of widespread screening. One provider noted: "I think that we would have to decide that ... the prevalence and importance was higher than the other things we track. I frankly don't know that it is." Similarly, because providers generally do not see elevated lead levels in King County frequently, some felt that lead poisoning dropped off their differential diagnoses. As one provider stated, "[Lead screening is] just not something that we have to come into contact with that often, and so that knowledge kind of atrophies a little bit."

Many but not all providers interviewed expressed that the invasiveness of venous blood draws is a significant barrier, especially when working with young, preverbal patients. "[A venous draw] is a major inconvenience and a patient/parent dis-satisfier, to get a fat one-year-old and try to get a vein and do a venipuncture," a provider stated. This is especially challenging due to the large number of preventative care actions to be taken at well child appointments.

Other barriers mentioned in clinics serving high income patient populations included financial reimbursement for the test and parental refusal, most commonly due to invasiveness of the test, but also to parents questioning the necessity of the test. Another barrier cited for higher income patient populations was fear of financial repercussions for remediation work if lead was found on a property. In low income clinics, specific barriers included patients not coming in for preventative visits, patients not having the time or resources to wait to get an extra test or travel to outside labs, and a general lack of options and multitude of life stressors for families of low socioeconomic status. These perspectives are included in Table 6.

Table 6: Representative Quotes Regarding Barriers to Screening

<i>Providers with Low Income Patient Populations</i>	<i>Providers with High Income Patient Populations</i>
“Because a lot of our patients live in Section 8 housing, and they have no idea when their apartment was built. They’re just like, ‘We have cockroaches, we can’t get the landlord to do anything about it, we have mold all over, we’re just trying to live.’”	“We would lose significant money on every test... We’re not against it, but I’m not going to subsidize something that has almost zero opportunities to pick up.”
“For many of our families, [unless] their child looks ill or they’re worried or they need a vaccine for something...they don’t necessarily come back.”	“[I have] more of a university faculty and graduate student kind of patient population that really wants to know the evidence and rationale for screening. I think I have to make a really strong case for them to feel compelled to get screening for their child.”
“We almost exclusively send [patients] to the lab where there are phlebotomists who...are just excellent at getting the stick. But that means instead of being here at the clinic, they now need to take time off of work or away from their life and have to go up to Seattle Children’s where they get that blood draw... patients who use Hopelink or ride the bus or don’t have transportation.”	“I have a pretty sophisticated patient population myself, so I have had some families recognize that there is going to be a repercussion if we find lead for their real estate... There’s going to be a lead mitigation that I think my sophisticated patient population knows that that’s going to cost them to figure out where it is and what it is. It’s reportable with the sale of a home.”

Strategies to Overcome Barriers to Screening

Regarding strategies to increase screening rates, many of the providers mentioned that the easiest way to do this would be to combine lead testing with an anemia screen at a well child check, both accomplished with the same capillary draw. Anemia screens, done by checking a hemoglobin level, are generally but not always performed at 9 or 12 months. “It would be ideal if we could put it in with our 9 month well child visit,” one provider noted, “except clinically that doesn’t really make sense because the child’s not walking very much. We already need a poke for hemoglobin so it would be very easy to add that on.” As stated, combining the lead screen with the anemia screen may be an imperfect solution, depending on when hemoglobin testing is performed, because some children are not yet ambulatory at 9 months and thus would not be regularly exposed to lead in residential house dust or soil.

Suggestions from providers working in higher income clinics were generally different from those working in low income clinics, primarily due to different barriers faced by their patient populations (Table 7). Thoughts from providers in higher income clinics ranged from better financial reimbursement for testing in private practices to online risk identification quizzes for parents. Several providers working in low income clinics suggested combining lead screening with other early childhood services that patients desired. One provider discussed combining efforts to increase lead screening with efforts to increase participation in early childhood development programs such as Head Start and Early Head Start, which serves infants and toddlers under the age of three. Another suggested that Medicaid patients who participate in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) have

hemoglobin and lead capillary tests performed at WIC offices to alleviate the burden on the primary care clinics.

Table 7: Representative Quotes Regarding Strategies to Increase Screening Rates

<i>Providers with Low Income Patient Populations</i>	<i>Providers with High Income Patient Populations</i>
<p>“It’s frustrating because some families who are also on WIC will say, ‘Oh no, we got our blood test already at the WIC office,’ and then I have to ask, ‘Did you just get a hemoglobin done, or did you also get a lead?’ And the parents are like, ‘I don’t know, we got something...’ Now you’ve put me in a weird spot; I’ll order it and now you have to decide if you’re going to do it or not...So if the WIC offices also had the lead level too...that would also be really helpful. And if they communicated that effectively to us.”</p>	<p>“People are lining up to do online quizzes to find out what kind of potato they are. I mean why can’t they do something that’s meaningful, like screening their kids for lead risk?”</p>
<p>“Of all the things to do in primary care, the two that have the highest and most studied benefits are immunizations and early childhood education...if I’m trying to be strategic, I would say this is a piece of what we really want, which is brain development. And the biggest thing here is early childhood education. And the family doesn’t want lead screening. They don’t know about it, they don’t want it...But families do want the best for their kids... when I think about lead strategy, if I were to say what do I really want? I would be like, you know what lead people, how about we band together with our early childhood people?...Our lead strategy should be universal early childhood education, and within that, we can consider the other things that need to be done.”</p>	<p>“So my view of this is, if the state were to come in and pay for the testing or subsidize it in some way that made it cost neutral even, I think there would be a lot more buy in for something like that.”</p>

Other general strategies mentioned included tracking lead screening as a quality metric, having the Health Department send reminders about patients who needed to be screened, increasing

information sharing about lead screening practices between clinics, and increasing provider awareness through educating medical students and residents in both pediatrics and family medicine.

Discussion/Conclusion

Improvement in pediatric lead screening rates in Washington State will benefit from an understanding of the current knowledge, attitudes, and practices of local pediatric providers. This study attempts to characterize these factors. The majority of pediatric providers participating in this project agreed that primary care for children aged 12 and 24 months should include lead exposure screening, which is consistent with national guidelines.¹⁶ However, only 39% routinely do lead screening at least once during that time period, and 30% report not knowing what lead exposure risks exist in King County. Factors seeming to affect whether or not a provider was a high versus low screener included knowledge around lead exposure, knowledge of national (AAP) or local guidelines (DOH), opinion regarding risk in their patients, and presence or absence of clinic system or policy regarding lead exposure.

Screening practices amongst providers who participated in interviews ranged from no screening at all to universal screening through exposure history intake forms and blood lead testing when indicated. Major barriers to screening included a general confusion around prevalence levels of lead exposure in King County and the invasiveness of venipuncture blood lead testing. The most common strategy mentioned to overcome low screening rates was combining lead screening with a routinely ordered hemoglobin screening test.

Several barriers to blood lead screening in other areas of the United States have been reported in the literature. These include beliefs that the prevalence of elevated blood lead levels is low in a provider's area, time constraints and provider opinion that there are other issues to prioritize, provider disagreement with recommendations, parental non-compliance with BLL testing, and financial cost of widespread testing.^{19,20,21,22} All of these barriers were mentioned by King County providers in SSIs. The notable barriers identified on the survey were (1) uncertainty as to when to screen/order a blood lead test; and (2) lack of clinic policy or system to remind a provider to do so. While risk factor identification is the basis of screening decision making, survey results demonstrate that approximately one third of providers do not know what the risk factors for lead exposure are in King County. Relatively few of providers in our survey noted lack of time to conduct a lead exposure history or experiencing parental refusal when ordering a blood lead test (17% for each). Inadequate financial reimbursement for blood lead lab tests was not an important concern in our survey (4%).

The findings of this investigation indicate widespread heterogeneity between clinics regarding their lead screening practices, even amongst clinics serving patient populations with similar demographics. This suggests that there will not be a single strategy that will be effective for all clinics while attempting to move lead screening forward, but rather different strategies for different clinic types. Enhancing knowledge on lead exposure risk factor identification and availability of related state guidelines and tools, such as a lead screening algorithm, issued in 2015 are needed.¹⁶ One approach may be to utilize a risk factor identification form at well child appointments for children ages 12-24 months to highlight whether or not a child is at risk. This

may be a relatively low burden intervention, considering that none of the providers reported exposure histories taking more than five minutes in the course of an appointment.

Continued provider education regarding risk factors for lead exposure is critical, especially in light of a statistical association between the low screening group and lack of knowledge as to when to screen. Survey results suggest that pediatric providers in King County access much of their information online, as well as from peer-reviewed journals and colleagues. The AAP/Bright Futures guidelines were those most known to survey participants. These findings indicate that knowledge-based interventions may be most effective if offered online, that the Washington Department of Health website should be promoted as a credible resource and mentioned in association with AAP programs or guidelines.

Another factor directly correlated to frequency of screening was the presence/absence of clinic policies around lead screening. Accordingly, a strategy for increasing screening rates would be standardization of clinic policies around screening. Such policies could include reminders in the electronic medical records for at risk patients, clear directed communication from public health authorities as to which patients should be screened, and incentivizing screening through tracking screening rates as a performance metric.

Many providers expressed confusion about what the current prevalence of lead poisoning actually is in Washington State. While it is impossible to know prevalence data without high rates of screening, it will be important to publicize estimates so that providers have the ability to make informed decisions as to which patients to screen.

Throughout the SSIs, providers continually alluded to greater ease of lead screening if screening were combined with other tests, such as a hemoglobin check for anemia. It is possible that doing this at appointments other than the 12 month well child check may be more effective, because there are less vaccinations performed at other appointments.²³

Others also mentioned early childhood development initiatives such as Head Start/Early Head Start, and the opportunity to encourage more families to take advantage of these programs that require blood lead testing for enrollment. Local partnerships between pediatric clinics and Head Start/Early Head Start have proven successful at significantly increasing enrollment of eligible children into the Head Start program.²⁴ An approach that harnessed these kinds of partnerships could lead to increased screening rates due to (1) higher enrollment in Head Start/Early Head Start generally, and (2) a more organized system of lead screening as a prerequisite to enrollment. While there is evidence that enrollment in Head Start/Early Head Start is not necessarily linked to increased blood lead testing rates, lead screening programs have successfully worked with Head Start/Early Head Start programs in other parts of the country.^{5,25,26} This suggests that similar partnerships could be successfully developed in King County. Co-benefits of this strategy would lead to higher rates of lead screening and more children accessing much-needed early education services.²⁴

Strengths and Limitations

This study has several limitations. First, survey responses may not be fully representative of all providers in this area due to the fact that providers filled out surveys voluntarily. Practice

patterns and knowledge and experience may differ from a more general sample. We had overrepresentation of medical doctors in pediatrics so were not able to parse out differences among provider types. Physician response to web based surveys are often low, particularly without pre-notification or incentives. Our estimated response rate was roughly 20%, roughly consistent with physician response to web based surveys without pre notification or incentives.²⁷ Despite limitations, this investigation provides initial insight into lead screening practices and barriers to lead screening faced by pediatric providers in King County, WA. Previously, there are no data in this region regarding this topic. Furthermore, by using a mixed method approach of general survey and SSIs provided an opportunity for more in depth and nuanced understanding of barriers faced by King County in attempting to increase its lead screening rates. The findings provide support for a set of strategies that are likely to support this goal.

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Appendix A: Survey Form

Do you currently see patients under the age of six?

- Yes
 No

Have you participated in any other surveys or interviews about lead exposure risk or blood lead testing in the last year?

- Yes
 No

Do you practice medicine in King County?

- Yes
 No

What is your **typical** practice for assessing your patient's lead exposure risk through exposure history questions? Please check all that apply.

- I always conduct a lead exposure history at least once during my patient's early childhood visits (age < 3 years)
- I conduct a lead exposure history if my patient's caregivers have questions or concerns about lead exposure
- I sometimes conduct a lead exposure history at least once during my patient's early childhood visits (age < 3 years)
- I do not conduct lead exposure histories
- Other (please specify)

What challenges do you face when deciding to **assess lead exposure risk through exposure history questions**? Please select up to three that you see as the biggest challenges.

- I am not sure when I should conduct a lead exposure history.
- I don't have time to conduct a lead exposure history in my routine pediatric care visits.

- I don't know what lead exposure risks are relevant in King County.
- There is no clinic system or policy in place to prompt me to conduct a lead exposure history.
- Other (please specify)
- I don't know the next steps to take based on results of a lead exposure history.
- I don't experience any challenges in conducting a lead exposure history.

What challenges do you face when deciding to [order a blood lead test](#)? Please select up to the three that you see as the biggest challenges.

- I am not sure when a blood lead test is indicated.
- There is inadequate financial reimbursement for blood lead lab tests.
- Caregivers refuse or are uncomfortable when I recommend blood testing for lead.
- I am unsure how to follow up with an elevated blood lead test result.
- Other (please specify)
- I am not comfortable interpreting blood lead test results.
- It is difficult to obtain reimbursement for blood lead lab tests.
- Patient must go to another facility for the blood sample for the blood lead test.
- I do not experience any challenges that affect ordering blood lead tests.

How strongly do you disagree or agree with the following statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Primary care for all children aged 12 to 24 months in King County should include a lead exposure history.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All children in King County should be tested for blood lead levels before the age of two.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

My pediatric patients are at risk for lead poisoning.

There are inadequate resources in my community to help my patients address sources of lead exposure that may be responsible for elevated blood lead levels.

Are you aware of any requirements or guidelines related to assessing lead exposure risk or blood lead testing?

- Yes
- No

What guidelines/requirements are you aware of?

- | | |
|--|--|
| <input type="checkbox"/> Public Health – Seattle & King County | <input type="checkbox"/> Medicaid |
| <input type="checkbox"/> American Academy of Pediatrics/Bright Futures | <input type="checkbox"/> American Academy of Family Physicians |
| <input type="checkbox"/> Washington Poison Center | <input type="checkbox"/> Centers for Disease Control (CDC) |
| <input type="checkbox"/> Washington Department of Health (WA DOH) | <input type="checkbox"/> US Public Health Taskforce |
| <input type="checkbox"/> Other (please specify) | |

Where do you typically access education and information to inform your clinical practices? Please select up to three.

- | | |
|--|--|
| <input type="checkbox"/> Online continuing medical education courses | <input type="checkbox"/> Peer-reviewed journals, including published practice guidelines |
| <input type="checkbox"/> Newsletters from medical organizations | <input type="checkbox"/> Grand Rounds |
| <input type="checkbox"/> Online clinical resources | <input type="checkbox"/> |

-
- Staff meetings
- In person professional conferences/Continuing medical education courses
- Other (please specify)
- Colleagues
- State or local health department website/personnel
-

Is there anything else you would like to share with us about assessing lead exposure risk and blood lead testing in King County?

What zip code is your clinic located in?

What is your profession?

- ND
- ARNP
- DO
- Other (please specify)
- MD
- PA

Are you currently in a residency program?

- Yes
- No

What is your specialty?

- Family medicine
- Pediatrics
- Other (please specify)

Where did you attend medical school?

- East Coast - US
- West Coast - US
- Another Country (please specify)
- Midwest - US
- South - US

How many years have you been practicing medicine?

Have you attended any professional presentations or continuing education sessions about lead in the past two years?

- Yes
- No

Appendix B: Interview Question Script

Thanks for talking to me today. I am an MD/MPH student, working with the UW Pediatric Environmental Health Specialty Unit and Seattle & King County Public Health. We are interested in learning more about King County pediatric health providers' current practices, protocols, and opinions about assessing for childhood risk of lead exposure. The goal of the interview is to help develop programs and services to prevent childhood lead exposure in King County and connect children with elevated blood lead levels to case management and other services.

I would like to record today's discussion for note taking purposes. Your name will not be attributed to your comments and the recordings will be deleted once the note taking is completed. Do I have your permission to record our conversation?

→ Yes

→ No

The interview will take approximately 15-20 minutes. Do you have any questions before we begin?

The first few questions ask about your opinions about lead exposure risk in King County.

1. How comfortable are you discussing the health impacts and management of lead exposure in children with your patients?
 - a. Probe: In a few sentences, could you expand briefly on what you know about lead exposure in children? (follow up: why, how?)
2. What is your opinion about the risk of childhood lead exposure in King County?
 - b. Probe: Who do you think is most likely to be at risk? (follow up: why, how?)

The next few questions ask about how you assess for lead exposure risk in children.

3. Under what circumstances would you assess children for lead exposure risk by taking an oral history?
 - a. Probe: Are there any systems, policies, or practices in place at your clinic that provide guidance asking patients about lead exposure?
 - b. Probe: What prompts you to assess a child for lead exposure risk?
 - c. Probe: How do you assess children for lead risk exposure?
 - d. Probe: How much time does it take during a patient visit to use exposure history questions to assess lead exposure risk?
(follow up: why, how?)
4. Under what circumstances do you order a blood lead test?
 - a. Probe: Do you perform capillary lead tests or venous draws?
 - b. Probe: Approximately, how many of your pediatric patients have blood lead capillary screens per year? And how many have venous draws?

- c. Probe: How much time does it take to conduct a blood lead test?
(follow up: why, how?)

5. If you did have a patient with an elevated blood lead level, would you know what further steps to take?

- a. Probe: Are you familiar with any resources for children with elevated lead levels that the Department of Health or other public health organizations have to offer?
(follow up: why, how?)

The next questions ask about what you have been taught how assessing lead exposure risk and blood lead testing.

6. What were you taught in your licensure program about assessing lead exposure risk?

- a. Probe: What were you taught about blood lead testing?
- b. Probe: Where did you do your clinical training?
(follow up: why, how?)

7. Where, if anywhere, have you received additional information about assessing lead exposure risk?

- a. Probe: Where have you received additional information about blood lead testing?
(follow up: why, how?)

The following questions address barriers you face as a provider when assessing lead exposure risk.

8. What factors make it difficult for providers to assess lead exposure risk or to conduct blood lead level testing?

- a. Probe: Institutional barriers, parent refusal
- b. Probe: How well-equipped is your support staff to do this test?
- c. Probe: How much of an issue is the extra time on top of the time necessary for routine vaccinations (eg 12 month vaccines)?
- d. Probe: Of these barriers, what ones are the most important to address?
(follow up: why, how?)

9. What strategies could help overcome these barriers?

- a. Probe: What would make it easier for you to assess lead exposure risk or order a blood lead level test?
- b. How would you like to receive more information/what's the venue through which you receive clinical information? (if you want to have more info?)
(follow up: why, how?)

The next few questions ask about Medicaid's blood lead testing requirements.

10. What do you know about Medicaid's blood lead testing requirements?
 - a. Probe: Have you heard about the requirements?
11. *If familiar:* What is your experience in receiving reimbursement for blood lead testing of pediatric Medicaid patients?
 - a. Probe: What works well in the reimbursement process?
 - b. Probe: What is difficult or challenging about the reimbursement process?

[Ask only for clinics in high lead exposure risk areas in the county (North Seattle, South Seattle, South King County)]

12. What do you think about to conducting universal blood lead testing at the 12 month and 24 month well-child visits?
 - a. Probe: Is this something you would consider?

The next questions address the demographics served by your practice.

13. How would you describe your patient population?
 - a. Probe: English language proficiency, race/ethnicity, family income, Medicaid
14. Is there anything else you would like to share with us about assessing for lead exposure?

Thank you again for your time. It is greatly appreciated.