Blood Lead Testing Among Medicaid-Enrolled Children in Michigan

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Background: Federal regulations mandate that Medicaid-enrolled children be tested for lead poisoning at the age of 1 and 2 years or 3 through 5 years if not previously tested.

Objectives: To measure the rate of blood lead testing among Medicaid-enrolled children in Michigan and the subsequent proportion of children with elevated lead levels and to determine factors associated with testing and elevated lead levels.

Methods: We performed a retrospective analysis of children aged 5 years or younger continuously enrolled in Michigan Medicaid during 2002.

Results: There were 216,578 children included in the analysis. The overall rate of blood lead testing was 19.6% (95% confidence interval [CI], 19.4-19.8) of which 8.3% (95% CI, 8.0-8.5) had a level of 10 µg/dL [0.48 µmol/L] or higher. Hispanic or nonwhite children or those living in high-risk areas for lead exposure were more likely to be tested and more likely to have an elevated blood lead level. However, 1.2% of tested children without these additional risk factors had a level of 10 µg/dL or higher. Enrollment in Medicaid managed care was associated with an increased likelihood of blood lead testing. After adjusting for other factors, those in managed care for 75% or more of their enrollment in 2002 had 1.98 (95% CI, 1.46-2.68) greater odds of being tested than those in fee-for-service for 75% or more of their enrollment.

Conclusions: The rate of blood lead testing was low. Patterns suggest testing was targeted to those at highest risk, potentially leading some children with elevated blood lead levels to be missed.

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Because of the harm of lead exposure on cognitive development, a national goal has been set to eliminate blood lead levels exceeding 10 µg/dL [0.48 µmol/L] by 2010. Although the prevalence of elevated blood lead levels among children 1 through 5 years has fallen substantially, from 88.2% in 1976 through 1980 to 2.2% in 1999 through 2000, 9.8% of children with an elevated blood level in 2001 had a value of 25 µg/dL [1.21 µmol/L] or higher.

Children from low-income families are at higher risk of having elevated blood lead levels. In 1998, Medicaid-enrolled children had a 3-fold greater risk of having an elevated blood lead level compared with those children not receiving Medicaid (8.5% vs 2.6%). To ensure early detection for those children at high-risk for having an elevated blood lead level, longstanding federal regulations mandate that children enrolled in Medicaid be tested for lead poisoning at the age of 1 and 2 years, or from 3 through 5 years (ie, 36-72 months) if not previously tested.

Despite these requirements, the rate of blood lead testing has been low. Across a sample of 8 states during the period of 1997-2001, the proportion of Medicaid enrollees 5 years or younger who received any blood lead testing ranged from 17.2% to 52.9%. However, the rate of testing has been reported to be higher than 75% in 2 communities among younger children.

We believe that one important reason that the overall rate of blood lead testing is low but variable across different communities is that primary care physicians tailor their screening practices to their understanding of the local risk of lead poisoning. Not surprisingly, despite the mandate for repeated testing of all Medicaid-enrolled children, testing tends to focus on those Medicaid-enrolled children at greatest risk of having an elevated blood lead level (eg, areas with more poverty or greater burden of lead exposure). Although targeting blood lead testing to those at highest risk for lead poisoning can significantly reduce the number of tests required, some children with elevated blood lead levels would be missed. Unfortunately, epidemiological surveillance data are unavailable for most communities to predict the outcome of targeted vs universal screening. Similarly, no data are available regarding the benefit of repeated universal testing as mandated.
Therefore, primary care physicians either follow the mandate, which may lead to overtesting in certain communities, or develop testing strategies based on outcomes of non-random testing, which may be biased and lead to missed cases of lead poisoning.

Regardless of this controversy, federal policy continues to mandate testing for all Medicaid-enrolled children. Since the mid 1990s, states have increasingly contracted with managed care organizations to provide care for Medicaid-enrolled children. Because managed care programs focus on preventive care and integrated services delivery, it was believed that these programs might lead to improvements in blood lead testing. However, to our knowledge, only one published study has directly compared the rate of blood lead testing between managed care and fee-for-service Medicaid plans; no difference in the rate of testing was found in the period 1995 through 1996.

We were interested in determining the degree to which children enrolled in Michigan Medicaid have blood lead testing at the recommended ages and the number of these children who have elevated blood lead levels. We hypothesized that the overall rate of blood lead testing would be low, but be higher among those children with other known risk factors (eg, living in areas with a greater lead burden, being of Hispanic or nonwhite race/ethnicity) and among those children enrolled in a managed care plan compared with those in fee-for-service. Although we expected more of the Medicaid-enrolled children with other known risk factors to have had an elevated blood lead level, we hypothesized that there was a significant proportion of children with no other known risk factors who had an elevated blood lead level.

DATA SOURCE

We performed a retrospective analysis of demographic, enrollment, and laboratory data for children enrolled in Medicaid during calendar year 2002. Demographic and enrollment data were obtained from Medicaid program enrollment files and were linked to lead results collected by the Michigan Department of Community Health (MDCH), Lansing.

Since 1997, each laboratory in Michigan has been required to report all blood lead results to the MDCH. The laboratories supply identifying information about each individual tested (eg, name, address, birth date), collection date, blood lead level test result, and the method of specimen sampling (eg, venous, capillary). These data are linked to other data sets maintained by the state, including the Medicaid enrollment files. Multiple data elements, including name, sex, and address, are used to link data sets, allowing for matches even if there is some error in some of the recorded data, such as a misspelled name. Bull Services Inc conducted an internal study in 2002 commissioned by MDCH that found the linkage process across all data sets to be more than 99% accurate (Tom Rotman; written communication; June 2004). This study was undertaken to test the accuracy of the match for purposes of overall calibration of the Unique Client Identifier system. Bull Services Inc believes the study was accurate for that purpose. It was based on a sampling of data and reflected the data sets at the time of the study (2002). The results of the study were not intended as a guarantee or warranty of accuracy for any selected matching process using Unique Client Identifier system at that time or in the future.

SUBJECTS

Children 5 years or younger (ie, <72 months) with continuous Medicaid enrollment in Michigan and no other health insurance during 2002 were included in this study. To be considered continuously enrolled, children younger than 1 year must have had no breaks in enrollment, and children 1 year or older could have no more than a 1-month gap in enrollment. Overall, there were 333,626 children 5 years or younger enrolled in Medicaid in 2002, of which 216,528 (64.9%) were continuously enrolled with no other insurance coverage.

OUTCOMES MEASURED

We measured 2 outcomes during 2002: the proportion of children who received blood lead testing and the proportion of tested children who had an elevated blood lead level. Some children had more than 1 blood lead testing during the year. For these children, we analyzed the first measurement only. Our primary threshold for an elevated blood lead level was 10 µg/dL or higher to reflect the current level of concern at which further evaluation and intervention is recommended. We selected a secondary threshold for an elevated blood lead level to reflect more severe lead poisoning, 25 µg/dL or higher, the threshold for action set in 1985. We did not evaluate the blood lead level as a continuous variable for 2 reasons: (1) the goal of initial testing is to first identify children with blood lead levels above the level of concern, and (2) because testing is nonrandom, we felt that analyzing the blood lead level as a continuous variable would imply a level of precision beyond that supported by our data.

INDEPENDENT VARIABLES

We evaluated the association of demographic and enrollment factors with the likelihood of receiving blood lead testing or of having an elevated blood lead level. These included age, sex, race/ethnicity, risk of lead exposure, urban or rural residence, and the number of months enrolled in either Medicaid managed care or fee-for-service plans.

We include several categories for age to calculate the rates of testing: aged 5 years or younger and 1 through 5 years based on birth date and date of testing, and the number of years of age at the time of blood lead testing. To classify children into this last category, the number of years at the time of blood lead testing, we categorized those children who were tested based on the date of testing and those children who were not tested as the number of years at the completion of the study period (December 31, 2002).

Race/ethnicity was categorized into 2 groups: non-Hispanic white and Hispanic or nonwhite. Insufficient data are available in the Medicaid enrollment files to separately analyze ethnicity from race or to include other race categories.

Children were categorized by ZIP code of residence as living in a high-risk area for lead exposure based on the incidence of lead poisoning, the stock of older houses, and the proportion of children living in poverty. Approximately half of the state is considered high risk. In some cases, we did not have complete address information. If the 2002 ZIP code was unavailable, we used the 2003 ZIP code. We considered Hispanic or nonwhite children or those children living in a high-risk area to have additional risk factors for having an elevated blood lead level.

Urban residence was classified according to metropolitan statistical areas (MSAs), as defined by the US Census Bureau. Each MSA is formed around an urbanized area of 50,000 or more inhabitants and includes adjacent communities if they are economically or socially integrated to the urbanized area. Each MSA is composed of 1 or more counties. In Michigan, 26
of 83 counties are classified as an MSA. Unlike the ZIP code data, complete county information was available. Medicaid enrollment was categorized as mostly managed care (managed care ≥79% of enrollment period in 2002), mostly fee-for-service (fee-for-service ≥75% of enrollment period in 2002), or mixed fee-for-service vs managed care.

Because capillary blood sampling may lead to falsely elevated blood lead levels,17 we included the blood sampling method in our evaluation of factors associated with having an elevated blood lead level. Blood sampling method was not considered as a factor associated with testing.

**STATISTICAL ANALYSIS**

We determined the proportion of children who received blood lead testing and the proportion of those tested who were found to have an elevated blood lead level; 95% confidence intervals (95% CIs) were calculated based on a binomial distribution. We then analyzed the bivariate relationship between each individual independent variable and (1) the proportion of all children who were tested who had an elevated blood lead level; 95% confidence intervals (95% CIs) were calculated based on a binomial distribution. Stata 8.2 software (StataCorp; College Station, Tex) was used for all analyses. This study was approved by the University of Michigan Medical School institutional review board, Ann Arbor.

Table 1. Demographic Characteristics of the Study Population*

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<tr>
<th>Demographic Characteristic</th>
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<tr>
<td>Age, y†</td>
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<tr>
<td>&lt;1</td>
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<tr>
<td>5</td>
<td>13.6</td>
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*Data are given as percentages unless otherwise indicated. †Age as of December 31, 2002.

We used 2003 ZIP code data to classify 54,692 (25.3%) of the children because no 2002 address was available. Most of these children (n = 51,298 [93.8%]) were younger than 1 year at the end of 2002. Based on our classification, most children in the study population lived in high-risk areas.

Among children with an urban residence, there was a greater proportion of Hispanic or nonwhite children compared with non-Hispanic white children (54.5% vs 8.9%; P <.001). Children in urban areas were also more likely to have mostly managed care Medicaid (70.9% vs 52.6%; P <.001). Although there was no difference in the proportion of children living in high-risk areas for lead exposure by urban (74.4%) or rural residence (74.5%; P = .74), children in high-risk areas were more likely to have mostly managed care Medicaid (70.3% vs 60.4%; P <.001).

The rate of blood lead testing for children 5 years or younger was 19.6% (95% CI, 19.4%-19.8%; n = 42,434) of which 8.3% (95% CI, 8.0%-8.5%; n = 3,522) had a blood lead level of 10 µg/dL or higher and 0.5% (95% CI, 0.5%-0.6%; n = 224) had a blood lead level of 25 µg/dL or higher. Of those children tested, 62.0% had venous samples, and 31.6% had capillary samples. The blood sample type was missing for 6.4% (n = 2,705), all among children who had blood lead levels lower than 10 µg/dL.

Most children tested and subsequently found to have an elevated blood lead level were 1 through 5 years old. Among these children, the rate of blood lead testing was 22.8% (95% CI, 22.6%-23.0). Of those tested, 8.7% (95% CI, 8.4%-9.0; n = 3,284) had a blood lead level of 10 µg/dL or higher and 0.6% (95% CI, 0.5%-0.6%; n = 213) had a blood lead level of 25 µg/dL or higher.

**FACTORS ASSOCIATED WITH BLOOD LEAD TESTING AND WITH ELEVATED BLOOD LEAD LEVELS**

Table 2 gives the bivariate associations between the individual independent variables and (1) the rate of blood lead testing, and (2) the proportion of tested children who had a blood lead level of 10 µg/dL or higher. Age, race/ethnicity, living in a high-risk area, rural or urban residence, and managed care enrollment were associated with the likelihood of blood lead testing and of having an elevated blood lead level (P <.001). In addition, elevated blood lead levels were also associated with sex and blood sampling method (P <.001).

Table 3 summarizes factors associated with testing or having a blood lead level of 10 µg/dL or higher adjusted for all covariates and the clustering by rural or urban residence. Compared with other children 5 years or
younger, 1-year-old children had the greatest odds of receiving blood lead testing (P<.001). The next highest peak in testing is among 3- and 4-year-old children. The odds of having an elevated blood lead level were similar for children aged from 1 through 5 years.

Sex was not associated with testing. However, among tested children, boys had 16% greater odds of having an elevated blood lead level.

Compared with non-Hispanic white children, Hispanic or nonwhite children had over 2-fold greater odds of being tested for lead poisoning. Among those who were tested, the odds of having an elevated result was over 3-fold higher for Hispanic or nonwhite children.

Children living in high-risk areas had a 50% increase in the odds of being tested compared with those in low-risk areas. However, among those tested, those living in a high-risk area had over 3-fold higher odds of having an elevated blood lead level. Independently, having urban residence was associated with 17% greater odds in the likelihood of blood lead testing but nearly 3-fold higher odds of having an elevated blood lead level.

Longer enrollment in Medicaid managed care was associated with higher odds of receiving blood lead testing but nearly 3-fold higher for Hispanic or nonwhite children.

In the bivariate analyses, venous blood sampling was associated with having an elevated blood lead level. However, sampling method was only marginally associated after adjusting for all other factors.

### EFFECT OF HAVING ANY RISK FACTOR IN ADDITION TO MEDICAID ENROLLMENT

Overall, 80.7% (n=174,721) of the children had other potential risk factors (ie, Hispanic or nonwhite children, or living in a high-risk area), 18.9% (n=40,822) did not have these additional risk factors (ie, white children living in low-risk area), and for 0.5% (n=1035) missing data precluded classification. Children with any potential risk factor were more likely than those without risk factors to be tested (21.9% vs 10.0%; P<.001). The proportion of tested children who had an elevated lead level of 10 µg/dL or higher was also greater among those with added risk factors (9.0% [n=3457] vs 1.2% [n=47], P<.001).

Of the 224 children with a lead level of 25 µg/dL or higher, only 1 did not have one of these additional risk factors.
factors; 90.6% (n = 203) were Hispanic or nonwhite, and 96.9% (n = 217) lived in a high-risk area. Most of these children (99.1% [n = 222]) also had an urban residence.

Despite the mandate for blood lead testing of all Medicaid-enrolled children, we found the rate of testing to be low, and similar to rates reported in the 1990s. Although most children with elevated blood lead levels had additional risk factors (eg, minority child or living in a high-risk area), some children without these additional risk factors were found to have an elevated blood lead level.

We found patterns suggesting that even among Medicaid-enrolled children risk factors drive testing. Children with additional risk factors had a greater likelihood of having an elevated blood lead level than those without these additional risk factors, suggesting that targeted testing is a cost-savings alternative to universal testing. However, the distribution of elevated blood lead levels found through nonrandom testing should not be confused with epidemiological surveillance data. We cannot infer the risk of having an elevated blood lead level in the large proportion of children who were not tested. These findings underscore the need for epidemiological surveillance data to guide local policy decisions.

We found that after adjusting for other potentially confounding factors, children enrolled in managed care had greater odds of receiving blood lead testing. The influence of managed care was “dose-dependent;” longer periods of enrollment in managed care were associated with increasing odds of being tested. We suspect that the increase in testing may be due to the fact that unlike fee-for-service Medicaid in Michigan, children enrolled in managed care are assigned a primary care physician.

Although the rate of blood lead testing was highest among 1-year-old children, we found a relative increase in the rate of testing among 3- and 4-year-old children that we believe is because of a requirement for blood lead testing prior to Head Start enrollment. Requirements for immunization prior to daycare enrollment or school entry have led to significant improvements; similar requirements for blood lead screening could increase rates of testing. However, requiring such testing prior to enrollment would necessarily apply to all children, regardless of insurance status or risk for lead poisoning, leading to increased costs with unknown added benefit.

There are several limitations of our analysis. Underreporting of blood lead test results by laboratories would lead to underestimates of the rate of testing. Because this is a cross-sectional analysis within 1 year, we cannot determine if these children had been tested previously. Cross-sectional analysis also does not allow us to account for a complete residential history leading to potential misclassification. Race/ethnicity is also challenging to properly classify and differences are not scientifically based, and our categorization likely grouped together individuals with diverse experiences and with different lead exposure. Finally, findings in Michigan, a state with a high burden of environmental lead, may not be generalizable to other areas of the country.

Consistent with earlier studies, we have found a low rate of blood lead testing among Medicaid-enrolled children, but a high prevalence of elevated blood lead levels among the tested children. Future studies are needed to assess the cost-effectiveness of increasing testing to meet the current federal mandate and to develop strategies to ensure that all children receive appropriate screening for risk of lead exposure.

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REFERENCES