The Peeling House Paint Hazard to Children

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THE occurrence of lead poisoning among small children living in poorly maintained homes in some centers of population in parts of the United States has been well established (*1–4*). Studies on urinary lead levels in the absence of symptoms of lead poisoning have been mentioned less frequently in the literature. This study was undertaken to determine whether or not abnormally high urinary lead levels might be found among Minneapolis children even in the absence of lead poisoning symptoms.

While no deaths from lead poisoning among small children have been reported to the Minneapolis Health Department for several years, and no diagnosed cases have been referred to the health department for followup, it was felt that there was enough uncertainty to warrant a study of urinary lead levels among small children attending well-child clinics.

Screening in Clinics

The children chosen for the study were those attending the well-child clinic at the Minneapolis Public Health Center, which is operated four times per week, with an average caseload of 17 per session. The clinic was chosen chiefly because the participating children come from all parts of the city rather than from any one area. This clinic has an additional advantage in that it is in the same building as the city public health laboratory. Financial eligibility standards restrict the families attending to those in the lower middle and low income brackets. Clinic service is available to children from birth until they enter school at 5 years of age.

Spot samples of urine were collected while the children were attending the well-child clinic. Very few urine samples were obtained from children under 2 years of age. If the child was unable to void, no further attempt was made to obtain a sample until the child again visited the clinic in his regular appointment schedule. Eliminated from the study were samples with an insufficient quantity of urine.

The urine samples were obtained through the use of a potty chair with a special laboratory tested leadfree vessel and were transferred immediately to a labeled, leadfree, Pyrex flask, with a large mouth and covered by an overlapping rubber cap. Urine specimens were kept in a refrigerator until picked up by the chemist.

Lead analyses were made in the Minneapolis Public Health Laboratory by Godfrey Nelson, using the modified dithizone method that has been used by the Minnesota Department of Health Laboratories since 1951. Preliminary work was done during the summer of 1958 by this worker in familiarizing himself with the laboratory technique. The urine specimens were also tested for albumen and sugar and for evidence of phenylketonuria. The results of these tests will not be reported in this paper.

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The study began on August 25, 1958, and was terminated on October 10, 1959.

Between August 25, 1958, and April 30, 1959, a total of 199 specimens of urine from children attending the well-child clinic were examined (table 1). Only one of these urine samples contained more than 0.08 mg. of lead per liter, which is considered the high point within the normal range. This high urinary lead was found on April 22, 1959 (tables 1 and 2).

Between May 1 and October 10, 1959, when the study was discontinued, 194 more urine samples were examined in the well-child screening program and 6 more were found to have high lead content. The high urinary lead cases found through the well-child clinic are cases 1, 2, 10, 11, 12, 15, and 16 in table 2. In these, the lead levels ranged from 0.10 mg. to 17 mg. per liter.

A home survey was made to determine the source of lead in all seven of the high lead cases found among the well-child clinic children. In each case a search was made for the usual sources of lead within the home, such as evidence of paint chewed off toys and cribs, chipping wall and floor paint, lead water pipes, and burning of storage battery cases. In several instances samples of tapwater were analyzed and found to be free of lead. While inside maintenance and housekeeping frequently left much to be desired, no obvious sources of lead within the homes were found except in cases 15 and 16. Inquiry was made as to pica, and was admitted in cases 11, 12, 15, and 16. The children in cases 11, 15, and 16 ate dirt while playing outdoors. The child in case 12 had been eating plaster, but an analysis of the plaster revealed no lead.

Followup on cases 15 and 16 showed the lead source to be lead dust brought home on the clothing of two men living in the multiple dwelling which housed the families of both children. Both men worked in the same stor-

Table 1. Findings of lead analysis of urine specimens from the well-child clinic of the Minneapolis Public Health Center during the period August 25, 1958–October 10, 1959, by month

Month	0.08 mg. per liter or less	More than 0.08 mg. per liter	Total tested
1958			
August	9	0	9
September	21	0	21
October	14	0	14
November	8	0	8
December	25	0	25
1959			
January	34	0	34
February	28	0	28
March	33	0	33
April	26	1	27
May	33	1	34
June	40	0	40
July	38	3	41
August	48	0	48
September	23	2	25
October	6	0	6
Total	386	7	393

Prevention of Lead Paint Poisoning in Baltimore

Activities aimed at protecting teething children from lead paint poisoning in Baltimore, started in 1931 by the city's health department, were expanded in December 1959. At that time, inspection teams of workers from the city health department and housing agency visited the homes of children of about a year old who attend the well-baby clinic of the Druid Health District, an area with a history of many lead poisoning cases among children. Parents are informed of the lead paint danger and samples are taken for analysis. Any paint containing lead is ordered removed.

Following initial coverage of about 250 homes, the schedule calls for testing 15 homes a week on a continuing basis.

In the first home visited after the project's inauguration, 16 out of 26 paint samples tested positive for lead. The visit also pointed up mass health education needs: an apartment in the building was being painted gaily for Christmas from cans clearly labeled as containing lead and not for use in interiors. Health authorities recognize the need for community cooperation from paint manufacturers, who must supply a wide selection of leadfree paints to mothers who will need to exert fullest vigilance over their small children's activities.—*From Baltimore Health News, February 1960.*

Table 2. Findings of initial and final analyses of urine in cases with high urinary lead, Minneapolis

Case No. and patient	Urinary lead levels				Final examination [1]			
	Date	Mg./liter	Date	Mg./liter	Date	Urine lead mg./liter	Hb. gm./100 cc.	Symptoms and medical findings
1. MS	4/22/59	0. 17	5/4/59	0. 18	10/28/59	0. 04	12. 0	None.
2. BD	5/13/59	. 14	6/22/59	. 14	7/8/59	. 14	--------	None.
3. RT	7/1/59	. 21	8/10/59	. 12				
4. GT	7/1/59	. 13	8/10/59	. 09				
5. MT	7/1/59	. 18	8/10/59	. 07				
6. GG	7/6/59	. 09	8/10/59	. 16	10/16/59	--------	12. 0	None.
7. LR	7/6/59	. 12						
8. RSp	7/13/59	. 11	8/10/59	. 20	10/22/59	. 06	12. 0	None.
9. RSw	7/13/59	. 16	8/10/59	. 08	10/22/59	. 04	11. 5	Poor appetite, vomiting, pica, earache, red drum.
10. DJ	7/14/59	. 14	8/10/59	. 08	10/22/59	. 04	13. 5	None.
11. KL	7/15/59	. 10	9/4/59	. 10	10/22/59	. 11	12. 0	Pica.
12. CR	7/22/59	. 16	8/11/59	. 17	10/1/59	. 06	9. 0	Pica, dietary deficiencies (hospitalized).
13. JM	8/10/59	. 30	8/12/59	. 28	10/29/59	. 03	12. 5	None.
14. MA	8/28/59	. 13	----------	--------	10/22/59	. 09	13. 0	None.
15. VS	9/11/59	. 12	9/21/59	. 07	10/22/59	. 07	12. 0	Pica.
16. HH	9/21/59	. 12	----------	--------	10/22/59	. 05	11. 0	Pica.

[1] In the final examination, none of the specimens showed stipple cells.

age battery manufacturing plant. One of the children played with the workshoes of one of the men. Paint cans were also found stored in the bathroom shared by both families. Analysis, however, showed the paint to be low in lead (0.6 percent). No loose paint was found on the multiple-dwelling house.

In the other five cases with high lead levels, no source of lead was found inside the homes. In each case, however, paint was peeling off the exterior of the houses. Upon questioning, it was found that the children usually played in areas immediately adjacent to the houses. There was no vegetation in these play areas, and particles of dried paint were mixed with the dirt. Analysis of this dried paint showed a lead content ranging from 12 to 42 percent, with an average of 24 percent.

Urine was not obtained from the preschool sibling of case 1. In the other cases, there were no siblings in the age range of 2 to 5 years.

Children in Selected Homes

Since the first two cases found in the clinic screening were believed to be related to chipping outside house paint and since the housing section of the Minneapolis Health Department was also interested in the health significance of chipping paint from the standpoint of housing maintenance, the study was expanded to include samples of urine obtained from small children who were known to be living in houses with exterior paint obviously peeling.

About July 1, 1959, a search began for such houses. Some were brought to our attention by the housing section. Others were spotted by Dr. Park while driving around the city on other health department business. When a house with badly peeling paint was surrounded by well-trodden ground close by, the occupants were asked whether or not the residents included children between the ages of 1½ and 5 years. If there were children of these ages, the visitor identified himself and the purpose of the study was explained. The mother was told that the health department wanted to determine whether or not the falling paint was creating a health hazard. Spot urine samples in leadfree flasks were obtained from the small children, and a sample of the falling paint was collected for lead analysis. At the same visit, the parent was urged to keep the children from putting the chipped paint in their mouths.

In the study of 14 homes with badly chipped or peeling paint on the exterior where there was evidence that the children played close to the house, analysis of the various paints showed

a high lead content, usually between 15 and 30 percent. Urine was obtained and analyzed from 24 of the young children living in these homes. Of the 24 children, 9 were found to have abnormally high lead levels in their urine samples (table 3). In only one house was more than one child found with high urinary lead content. In this home, three children aged 2, 3, and 4 years had lead in the urine measuring 0.18, 0.13, and 0.21 mg. per liter, respectively. These cases are 5, 4, and 3 in table 2. In none of the houses where a child was found to have high urinary lead were sources of lead observed other than the peeling exterior house paint. In this part of the study, only case 9 had a history of pica, according to the parents.

Findings From Poorly Maintained Homes

By combining the 5 cases of high urinary lead related to peeling exterior house paint, found through the well-child clinics, with those found in selected homes, a total of 14 children with high urinary lead levels was obtained. These were found among small children living in 19 homes with badly peeling paint wherein no other source of lead was found. The urinary lead levels in these 14 cases ranged from 0.09 to 0.30 mg. per liter (table 2, patients 1 through 14).

Twelve of the fourteen children provided urine specimens again about a month later. At this time the lead levels in the urine of five of the children were essentially the same as before, two had significantly higher urinary lead than previously, two had lower, and in three children, the urinary lead had fallen to normal level.

Three of the children (cases 3, 4, and 5) whose second urinary lead tests were either normal or distinctly lower than formerly, lived in the one house which was painted during the study. The painting was done at about the time the first urine specimens were obtained and further falling of paint thereby prevented.

Table 3. Findings of lead analysis of urine specimens from children living in selected houses with peeling paint in Minneapolis, by month, 1959

Month (1959)	Number of houses	Urine specimens		
		Number with lead 0.08 mg./liter or less	Number with lead more than 0.08 mg./liter	Total number tested
July	11	12	7	19
August	2	1	2	3
September	1	2	0	2
Total	14	15	9	24

Followup

During the month of October 1959, an attempt was made to give a final check to each of the 16 children who had high urinary lead levels. One child, case 12, with a hemoglobin of 9 grams had previously been referred to the Minneapolis General Hospital for more extensive studies because of marked pica and dietary deficiencies. The high urinary lead was verified by the hospital, and, although there were no physical findings nor symptoms warranting a diagnosis of lead poisoning, a 5-day course of ethylenediamine tetraacetic acid was considered justified. On the fourth day of the EDTA treatment, the urinary lead was 0.54 mg. per liter, and the blood level 0.04 mg. percent. At completion of the treatment, the urinary lead was found to be a normal 0.06 mg. per liter.

The remaining 15 children were asked to report to the well-child clinic for a physical examination by Dr. Hartman. Ten of the fifteen did report and, at that time, urine specimens were obtained from nine of them for lead analysis. Blood was obtained from all 10 for hemoglobin estimations and stipple cell counts. In seven of the nine urine specimens examined at this time, the lead levels were normal, and in the other two, readings of 0.09 and 0.11 mg. of lead per liter were obtained (table 2). None of the children had any stippling of red blood cells. The hemoglobin levels ranged from 11.0 to 13.5 grams per 100 cc. None of the children had exhibited any signs or symptoms pointing toward a diagnosis of lead poisoning, and this includes cases 3, 4, 5, and 7, who were seen by Dr. Park at the time the first urine specimens were collected. Cases 9, 11, 12, 15, and 16 had a history of pica. Parents were again warned about the hazards of children putting dirt in their mouths.

Discussion

We recognize that the use of spot samples of urine for lead analysis has limitations and may be open to question. Sometimes a case of lead absorption may be missed when only one sample is obtained. On the other hand, high urinary lead, when found in a spot sample, is an indication of excessive lead absorption. In this study, blood test lead was not determined because the children had no symptoms of lead poisoning, and there seemed to be no necessity to attempt to establish a diagnosis of lead poisoning.

The occupational health service of the Minneapolis Department of Public Health, under the direction of Dr. Park, has for several years been collecting and analyzing spot samples of urine to measure industrial exposures to lead. In this work it was found that spot urine samples are a reliable indication of the degree of lead absorption, if the following conditions are met: the urine samples are collected on separate days, the specimens are not contaminated with extraneous lead, and two or more specimens are in close agreement on lead content (*5*).

A similar experience, with spot urine testing for lead, was reported through personal communication by W. G. Frederick, of the bureau of industrial hygiene of the city of Detroit, in October 1956.

The possibility of contamination during collection of spot samples of urine, by the methods used in this study, may raise some doubt as to the validity of the results. We have found instances of contamination in industrial surveys, but the lead content in the urine in these cases has always been so excessive that contamination was immediately detected (*5*).

There is reason to believe that lead hazards inside of homes in our city are minimal, since a fair sampling of urine specimens (386) from children attending the well-child clinic were found to be normal in lead content. The children came from homes from all parts of the city from the lower middle and low socioeconomic groups. In the seven cases with elevated urinary lead levels among well-child clinic patients the lead source was traced to factors other than those within the homes.

Except for cases 15 and 16 the cases found through the well-child clinic were caused by chipping exterior house paint. Although the parents gave a history of pica in only two of these five children, it has been noted that mouthing of materials is an almost universal habit of young children, exclusive of pica (*3,6*). We therefore believe that the elevated urinary lead was caused by ingestion of the peeling house paint which was mixed in the dirt in which the children played.

All of the five cases were found in the spring and summer months of 1959 from among 199 specimens collected during the last week of August 1958 and April through August 1959 as compared with 2 abnormal lead levels among 194 urine specimens collected at other times of the year. These two cases were not caused by chipping outside house paint. This seems to support the suggestion of Baetjer (*4*) that children may have more opportunity to ingest exterior paints in the summer. Our study of elevated urinary lead even in the absence of symptoms of lead poisoning seems to parallel the seasonal incidence of lead poisoning found in Baltimore (*4*) and Boston (*3*).

If we take only those small children who are known to be exposed, that is, if we start with those in the selected homes as we did in the second part of this study, we get a very high proportion with high urinary lead (table 3). Of 24 children exposed to these conditions in 14 such houses, high urinary lead was found in 9. If we include the five children with high urinary lead levels who were found through the well-child clinics and who lived in the 5 separate houses in similar condition (cases 1, 2, 10, 11, and 12 in table 2), we get a total of 19 homes with peeling outside paint. In these 19 homes, urine specimens were obtained from 29 small children, of which 14 had high urinary lead content. This amounts to 48.3 percent of the urines examined and is comparable to the 44.4 percent found in Baltimore some years ago, when a more extensive study was made using specimens of blood instead of urine for the lead analyses (*2,7*).

In terms of the buildings themselves in relation to the number of small children with high urinary leads, we find that 19 peeling houses gave us 14 children with high urinary lead. This in terms of probability means that for every 100 such houses, with small children

living in them, there are likely to be 74 children eating enough of the falling lead paint to raise their urinary lead level above normal during the summer months. While not many will eat enough paint, over a long enough period, to cause manifest lead poisoning, this is a lead hazard which housing authorities and the Minneapolis Health Department cannot afford to ignore.

Conclusion

While this study does not cover sufficient numbers to warrant any definite conclusions, the following comments seem to be pertinent:

- The study did not reveal lead hazards to small children in Minneapolis which could be traced to conditions inside of the homes, although the possibility that such hazards exist cannot be completely excluded.
- The finding of some cases of high urinary lead levels among small children in the absence of symptoms of lead poisoning seems to parallel the seasonal incidence of lead poisoning found in children in other cities.
- The paucity of actual lead poisoning among small children living in poorly maintained houses in Minneapolis may be related to a shorter summer season (shorter exposure period) rather than to any difference in the hazard associated with falling exterior lead paint.
- Health departments and housing authorities, in concern for the health of small children living in houses where the exterior paint is chipping off, should consider developing control procedures (*8*).
- Parents and the public should be warned of the health hazard of small children ingesting the paint which has chipped off walls of houses and outbuildings.

Summary

Between August 25, 1958, and October 10, 1959, a total of 417 specimens of urine from children (5 years and under, without symptoms of lead poisoning) were analyzed for lead at the Minneapolis Health Department laboratory. Of these specimens, 393 were obtained through a screening program carried out in well-child clinics, turning up 7 with high urinary lead. The remaining 24 specimens were obtained from children living in houses selected for study because of their obviously peeling paint. Among the latter specimens, nine were found to be high in lead content. While screening through the well-child clinics lasted nearly 14 months, the study among children living in the preselected homes was carried out only during July, August, and September of 1959.

All of the specimens with high urinary lead were associated with peeling exterior house paint, except for two cases found through the well-child clinics. In these two instances the source of lead was traced to lead dust brought home on the clothing of two adults who worked in a storage-battery manufacturing plant. When the figures of the two studies are combined, 14 out of 29 children living in 19 houses with peeling paint had high urinary lead levels. All of these 14 children are believed to have ingested the lead although only 3 had a definite history of pica. The children played in the dirt adjacent to the houses where peeling paint had fallen into the play areas.

None of the children with high urinary lead manifested sufficient signs or symptoms to warrant a diagnosis of lead poisoning and by late October, almost all urinary levels had returned to normal.

All of the high urinary lead levels appeared during the summer, suggesting a seasonal outdoor exposure and the absence of significant all-year inside exposures.

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