LEAD EXPOSURE AT A SCHOOL FOR CHILDREN WITH DEVELOPMENTAL DISABILITIES

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In July 1994 a paediatrician reported that an autistic child aged six years had been admitted to hospital for chelation therapy with a blood lead level of 3.86 micromoles per litre. The child had ingested some granular material containing 23 per cent lead. This material was found in the child's home, where it was possibly used to treat rising damp.
In September 1994 the child was enrolled at a school for children and young people with developmental disabilities. In view of the child's history of pica and elevated blood lead level, the school environment was assessed for possible lead contamination. Because it was believed that many of the students at the school engaged in hand-to-mouth activities, they were also offered blood lead testing. This article reports the findings of the environmental and blood lead surveys, which were conducted in October 1994, and outlines interventions designed to reduce the lead burden.

METHODS

Environmental survey

The school principal identified areas in the school grounds where children played and attended classes. Environmental samples were collected from these areas, which included carpet, window wells, wooden floors, bare surface soil and peeling paint. The samples were tested for total lead using standard methods.

Survey of children

Parents received letters advising them to have their children tested for lead levels, either through their general practitioners or at special clinics held at the school. Class teachers completed a form giving demographic information about the children and information on the frequency with which they put fingers or objects into their mouths. Data analysis focused on the relationship between blood lead levels and children's behaviour and demographic characteristics.

RESULTS

Environmental study

The school's administration building was a refurbished two-storey Victorian-style erected in the 1880s. The classrooms and other facilities were located in buildings constructed in the mid- to late 1970s. A month before this investigation began, contractors were employed to repaint the administration building. They sanded back lead-painted exterior timber and masonry surfaces.

Very high levels of lead contamination were found on interior and exterior surfaces of the administration building. The classrooms and associated facilities contained low levels of lead, except for carpets in classrooms 2 and 4 (Table 2).

Survey of children

At the time of the survey 76 children were attending the school in years 1-11. Their ages ranged from 3 to 18 years (median 9 years), and 57 (75 per cent) were male. Teachers reported that 26 (34 per cent) children frequently, 8 (11 per cent) sometimes and 41 (54 per cent) rarely placed objects in

TABLE 2

ENVIRONMENTAL LEAD RESULTS FOR THE SCHOOL, OCTOBER 1994 – BEFORE AND AFTER ABATEMENT

Sample location and description (units)		Before abatement	After abatement	US EPA guidelines
Administration building				
Library	vacuum cleaner dust (mg/kg)	49,423	carpet removed	500-1,000
	dust wipe floor (µg/m²)	9,389	2,725[a]	1,076
	dust wipe window well (µg/m²)	16,451	9,941	8,608
	paint interior wall (% w/w)[b]	0.22	N/A	0.5
Staffroom	dust wipe floor (µg/m²)	8,050	2,619[a]	1,076
	dust wipe window well (µg/m²)	6,324	1,490	8,608
Office dust	wipe floor (µg/m²)	2,144	1,219[a]	1,076
	dust wipe window well (µg/m²)	3,818	1,611	8,608
Classroom	dust wipe floor (µg/m²)	2,736	1,756[a]	1,076
	dust wipe window well (µg/m²)	3,667	2,373	8,608
Paint	exterior wall (% w/w)	10.53	removed/covered	0.5
	interior bathroom wall (% w/w)	30.60	removed/covered	0.5
Soil	perimeter of building (mg/kg)	4,649	371	400
Classrooms and common areas				
Classroom 2	vacuum dust (mg/kg)	1,033	521	500-1,000
	paint hallway wall (% w/w)	5.45	removed/covered	0.5
Classroom 4	vacuum dust (mg/kg)	1,156	460	500-1,000
Other	vacuum dust (mg/kg)	184-563	248-417	500-1,000
classrooms	paint interior wall (% w/w)	0.06	N/A	0.5
Soil	(mg/kg)	77[c]	N/A	400
Paint	handrails (% w/w)	0.45	N/A	0.5
Water	first flush from bubbler (µg/l)	5	N/A	10

a new carpet on top
b percentage weight for weight
c arithmetic mean of 6 soil samples
N/A Not applicable since before abatement results are below standards

their mouths, and that 27 (36 per cent) frequently, 12 (16 per cent) sometimes and 37 (49 per cent) rarely placed their fingers in their mouths.

Forty-two (55 per cent) of the children had venipuncture for blood lead level determination. The median blood lead was 0.22 µmol/l (range 0.10-2.57 µmol/l), and five children (12 per cent) had elevated lead levels (>0.48 µmol/l). There were no significant differences between children with elevated lead levels and others by age, sex or grade. Children reported by their teachers to place objects or their fingers in their mouths frequently were significantly more likely to have lead levels above 0.48 µmol/l than children who rarely placed objects or fingers in their mouths (Table 3).

TABLE 3

CHARACTERISTICS OF CHILDREN TESTED FOR BLLs AT THE SCHOOL, OCTOBER 1994

Characteristic	Total	No. >0.48 µmol/l (%)
Age		
<10 years	21	3 (14)
≥10 years	21	2 (10)
Sex		
male	30	5 (17)
female	11	0 (0)
unknown	1	0 (0)
Class		
1-2	9	2 (22)
3-5	6	1 (17)
6-7	10	0 (0)
8-9	9	2 (22)
10-11	8	0 (0)
Objects in mouth[a]		
frequently	15	4 (27)
sometimes	5	1 (20)
rarely	21	0 (0)
unknown	1	0 (0)
Fingers in mouth[b]		
frequently	17	4 (24)
sometimes	5	1 (20)
rarely	20	0 (0)
Total	42	5 (12)

a chisquare for trend 5.8, p<0.02
b chisquare for trend 4.8, p<0.03

INTERVENTION

To reduce lead exposure school staff restricted student access to potentially contaminated areas. Temporary fences were erected around the contaminated soil, carpets were replaced, and floors, windows, cupboards and other surfaces and objects (including books in the library) in and around the administration building were thoroughly cleaned. Soil around the perimeter of the administration building to a thickness of 10cm was removed and the area was paved. All deteriorating paint was removed or encapsulated. Carpet in the classrooms was professionally cleaned. Cleaners were asked to wipe dust from painted wooden window wells and sills as a routine.

Repeat sampling after the abatement program showed soil lead contamination had been substantially reduced (Table 2).

The home environments of children with blood lead levels >0.72 µmol/l were also investigated for lead contamination, and their parents were advised on ways to reduce their children's lead exposure and to minimise absorption.

DISCUSSION

This investigation showed there was significant lead contamination in the school environment. Our findings indicate that children with developmental disabilities may be at greater risk of lead exposure due to their behavioural characteristics such as pica and frequent hand-to-mouth activity.

The remedial work undertaken at the school reduced environmental lead contamination, minimising the risk for students. While dust lead levels on the floor in the administration building remained high despite intensive cleaning, they were covered with new carpet to prevent access. This finding demonstrated the difficulty in removing lead dust from surfaces that are not smooth and reinforces the importance of minimising the dispersal of dust when removing lead-based paints. Lead dust levels remained high in window wells in the administration building due to the dust created by friction when the sash windows previously painted with a lead-based paint were opened and closed. Higher carpet dust levels in classrooms located closest to the administration building may be attributed to students and staff "tracking" contaminated soil and dust on their shoes from the administration building.

Lead is a potent neurotoxin that adversely affects many systems in the body, especially the central nervous system, the renal system and blood-forming tissues[1]. Recent studies have shown adverse neuro-psychological effects associated with elevated blood lead levels in children[2], including reduced intelligence quotient[3], attention deficits[4], aggression and destructive behaviours[5]. Damage to the central nervous system may be permanent, resulting in school failure and anti-social behaviour, and ultimately impairing productivity[4].

Levels of environmental lead contamination found in areas around the administration block of the school were well above North American intervention guidelines[6] (<0.5% in paint, 400 mg/kg in accessible bare soil in play areas, lead dust loading for floor <1076 µg/m², window sills, 5380 µg/m² and window wells <8608 µg/m²).

Twelve per cent of the 42 children tested had blood lead levels above the National Health and Medical Research Council goal (<0.48 µmol/l). This was no higher than levels found in preschool children in Central and Southern Sydney[7] but may be higher than expected for primary school children. Children in this study who frequently placed their fingers and other objects in their mouths were more likely to have high blood lead levels.

A major limitation of the survey was the disappointing response to the offer of blood lead testing, with only 55 per cent of students being tested. The extent to which this group represented the school's entire enrolment is unknown. Another limitation was the reliance on teacher reports of hand-to-mouth activity after the blood screening of students.

This investigation was initiated in response to a need to protect a child with a history of an elevated blood lead level.

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TABLE 4

NSW PUBLIC HEALTH UNITS

Code	Unit	Address	Phone	Facsimile
CC PHU	Central Coast Public Health Unit	PO Box 361 GOSFORD 2250	043 20 4545	043 20 4550
CS PHU	Central Sydney Public Health Unit	PO Box 374 CAMPERDOWN 2050	02 550 6810	02 565 1690
CW PHU	Central West Public Health Unit	PO Box 143 BATHURST 2795	063 32 8505	063 32 8577
ES PHU	Eastern Sydney Public Health Unit	Locked Bag 88 RANDWICK 2031	02 313 8322	02 313 6291
HUN PHU	Hunter Public Health Unit	PO Box 11A NEWCASTLE 2300	049 29 1292	049 29 4037
ILL PHU	Illawarra Public Health Unit	PO Box 66 KEIRAVILLE 2500	042 26 4677	042 26 4917
NC PHU	North Coast Public Health Unit	PO Box 498 LISMORE 2480	066 21 7231	066 22 2151
ND PHU	Northern Districts Public Health Unit	PO Box 597 TAMWORTH 2340	067 66 2288	067 66 3003
NS PHU	Northern Sydney Public Health Unit	Hornsby Ku-ring-gai Hospital Palmerston Road HORNSBY 2077	02 477 9400	02 482 1650
SE PHU	South Eastern Public Health Unit	Locked Mail Bag 11 GOULBURN 2580	048 27 3428	048 27 3438
SS PHU	Southern Sydney Public Health Unit	PO Box 482 KOGARAH 2217	02 350 3377	02 350 3474
SW CPH	South West Centre for Public Health	PO Box 503 ALBURY 2640	060 58 1700	060 58 1701
SWS PHU	South Western Sydney Public Health Unit	Locked Bag 17 LIVERPOOL 2170	02 828 5944	02 828 5955
WN PHU	Western NSW Public Health Unit	PO Box M61 EAST DUBBO 2830	068 81 2235	068 84 7223
WS PHU	Western Sector Public Health Unit	13 New Street NTH PARRAMATTA 2151	02 840 3603	02 840 3608

(Compiled by the South West Centre for Public Health on behalf of the Public Health Network)

Lead exposure at a school

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As a consequence an environmental assessment of the child's new school was carried out. Subsequently, other students at the school were offered blood lead testing and public health action was taken to reduce lead exposure within the school grounds. The study highlighted the benefits of notification of elevated blood lead levels to public health authorities, following NHMRC recommendations. Public health action can then be taken to reduce exposures. The study also drew attention to the value of targeting children with developmental disabilities for lead screening, especially those in potentially contaminated environments and those who frequently engage in hand-to-mouth activity.

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3. McMichael AJ, Baghurst PA, Wigg NR et al. Port Pirie cohort study: Environment exposure to lead and children's intelligence at the age of seven years. *N Engl J Med* 1992; 327:1279-84.
4. Needleman H, Schell A, Bellinger D, Leviton A, Allred EN. The long-term effects of exposure to low doses of lead in childhood. An 11-year follow-up report. *N Engl J Med* 1990, 322:82-88.
5. Sciarillo WG, Alexander G, Farrell KP. Lead exposure and child behaviour. *Am J Public Health* 1992; 82:1356-1360.
6. National Centre for Lead Safe Housing. Guidelines for the Evaluation of Lead-based Paint Hazards in Housing. February 1995.
7. Mira M, Bawden-Smith J, Causer J, Alperstein A, Karr M, Snitch P, Waller G, Fett J. Blood lead concentrations of urban Australian children. Submitted to *Am J Paed.*