ASSESSING THE IMPACT OF A NEW MOTORWAY ON CHILDREN'S BLOOD LEAD LEVELS

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This article reports on surveys of blood lead levels in children attending a primary school adjacent to a new four-lane motorway. The surveys were carried out immediately after the motorway was opened in 1993, and again one year later.

It has been estimated that emissions from motor vehicles are responsible for the major part of Australian children's body burden of lead[1]. Other major sources of environmental lead exposure include point sources such as lead smelters, and deteriorating lead-based paint. The impact of leaded petrol on children has received increasing political, public and media attention in recent years and has been the subject of a federally-funded health promotion campaign[2]. International studies have detailed the contribution of heavy traffic to environmental lead and schoolchildren's blood lead levels[3,4].

The day before the four-lane M23 motorway opened on June 24, 1993, parents and teachers at a school in suburban Newcastle, NSW, raised concerns about possible environmental lead contamination from traffic using the motorway. The school principal asked the Newcastle Environmental Toxicology Research Unit (NETRU) to conduct a survey of children. The objectives were to measure baseline blood lead levels and to assess the impact of one year's traffic use of the motorway by repeating the blood lead testing in 1994. Estimates of the traffic volume on the motorway were not available.

NETRU and the Hunter Public Health Unit (HPHU) undertook to offer blood lead testing to the children at the school as a community service. However, the surveys also provided potential opportunities to examine dose-response relationships between traffic volumes and blood lead levels of children, thereby contributing to scientific understanding of the impact of lead exposure. Accordingly, information was collected on children's blood lead levels and on lead levels in soils and dusts.

METHOD

Initial survey

All children and teachers at the school were offered blood lead testing. The children's ages ranged from five to 13 years. Initial testing was carried out in July 1993, 10 school days after the motorway was opened. The test procedure was approved by the NSW Department of School Education, but the survey proposal was not submitted to a research ethics committee because the investigation was conducted as a matter of urgency. Children participated in the initial survey only with the written consent of their parents or legal guardians. Experienced blood collectors from the Hunter Area Pathology Service (HAPS) obtained samples by venipuncture over a three-day period, drawing sufficient

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the levels seen above 0.72 µmol/l (15 µg/dl) will not. There is a pressing need to obtain the baseline data specified in the NHMRC recommendations for the preschool population at high risk of lead exposure.

In summary, the articles highlight the need for clear policy regarding research and surveillance of blood lead levels among high risk exposure groups; policy regarding environmental evaluation, blood lead testing and abatement of lead contamination; and a commitment to action.

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EDITOR'S COMMENTS

With regard to Dr Alperstein's recommendations:

- During 1995 the NSW Department of School Education carried out environmental sampling in five Special Education schools with buildings constructed before 1970 and which had recently undergone cyclic maintenance. One of the schools was found to have high lead levels in carpet dust and the carpet was replaced. No excessive lead levels were found in the other four schools.
- A Lead Reference Centre is being established in December 1995. It is a joint initiative of the NSW Environmental Protection Authority and the NSW Health Department, with other participating agencies. The Centre is at the Gladesville Hospital premises of the Health Department's Public Health Division.
- A national survey of blood lead levels in preschool-aged children was completed in June 1995. The survey was carried out under the auspices of the Australian Institute of Health and Welfare. Only preliminary results were available at the time of writing, and a full report had not been published.

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blood from each child for a full blood count (FBC) and lead assay.

On the day of blood collection, children were given letters to their parents or guardians informing them of the anticipated date results would be available. Within three weeks all results had been processed and reviewed by a medical practitioner. Written results were given to parents and guardians, accompanied by an explanatory letter and information on how to contact a member of the survey team for further information and discussion if desired.

Soil and dust samples were collected by HPHU Environmental Health Officers, using an Environment Protection Authority (EPA) protocol adapted for the site[5]. The samples were sent to the analytical laboratory at Pasminco-Metals Sulphide, Boolaroo.

Follow-up survey

NETRU and HPHU conducted the repeat survey in July 1994, again offering blood lead testing to all children and teachers at the school. Three weeks before the 1994 survey, letters were sent to the children's parents or guardians informing them of the second round of testing and seeking written consent for venipuncture, FBC and blood lead estimation. The schedule and procedure for blood testing and distribution of results followed the 1993 protocol.

The follow-up testing was also offered to children who had attended the school in 1993 but had since left. With the consent of their parents or guardians, these children had venipunctures at the school or at the John Hunter Hospital Outpatients Department.

HPHU Environmental Health Officers repeated soil and dust sampling.

Aggregate results of the two surveys were not reported or published until all individual results were distributed and parents had received a summary of the aggregate results in a school newsletter.

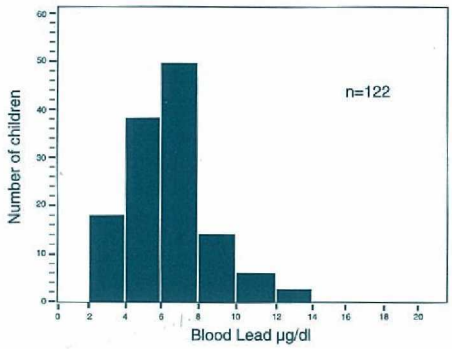
To avoid confusion, results were explained (by letter or in person) to parents and guardians in micrograms per decilitre (µg/dl), although results were also presented in micromoles per litre (µmol/l). It was believed that there had been substantial community discussion about "goals" of 10µg/dl and "actions" at 15µg/dl to warrant a need for consistency. Results in this article are reported in µg/dl, followed by µmol/l in square brackets. (Results in µg/dl may be converted to µmol/l by dividing by 20.714.)

Results

Ninety-five schoolchildren had a test in 1993, and 122 in 1994, giving response rates of 60 per cent and 65 per cent respectively. Of the 73 children who had a test in 1993 and were still at the school in 1994, 65 had a second test in 1994 – a follow-up rate of 89 per cent. Of the 22 children who had tests in 1993 and had left the school by July 1994, only three were retested – a response rate of 14 per cent. In 1994, 57 children had a blood lead test for the first time, so a total of 152 children had at least one test, either in 1993 or in 1994.

The mean blood lead level of the 122 children at the school in 1994 was 6.23µg/dl (95% confidence interval: 5.87-6.6) [0.30µmol/l; 95% CI: 0.28-0.32]. This was very similar to the mean for the 95 children tested in 1993 of 6.16µg/dl (95% CI: 5.73-6.58) [0.30µmol/l; 95% CI: 0.28-0.32]. The levels in 1993 ranged from 1.7µg/dl to 14.1µg/dl [0.08µmol/l to 0.68µmol/l], and in 1994 from 2.5µg/dl to 13.9µg/dl [0.12µmol/l to 0.67µmol/l]. The distribution of the results in 1994 is illustrated in Figure 1.

DISTRIBUTION OF RESULTS, SCHOOL BLOOD LEAD SURVEY, 1994



The same proportion of children in 1993 and 1994 (4 per cent) had blood lead levels of 10µg/dl [0.48µmol/l] or more, the National Health and Medical Research Council (NHMRC) goal for all Australians. No child required individual attention, which is recommended by the NHMRC in children with a blood lead level of 15µg/dl or greater.

The mean blood lead of the children tested twice was 6.39µg/dl (95% CI: 5.81-6.97) [0.31µmol/l; 95% CI: 0.28-0.34] in 1993 and 5.95µg/dl (95% CI: 5.44-6.46) [0.29µmol/l; 95% CI: 0.26-0.31] in 1994. This reduction of 0.44µg/dl is significant (95% CI: -0.77 to -0.096µg/dl), but is consistent with the decrease in blood lead seen in children with increasing age.

Environmental lead levels were assayed from samples collected at seven sites in 1993 and six sites in 1994 (Table 1). Site 2 could not be retested because no loose dirt or dust was present in 1994. The mean concentration in 1993 (arithmetic mean 182ppm, geometric mean 87ppm, 95% CI: 26-293) was very close to that in 1994 (AM=183ppm, GM=112, 95% CI: 34-362); confidence intervals were very wide because of the small numbers of samples. These data suggest no major change in lead burden in soils and dusts over the year. Importantly, the upper confidence limit for 1993 did not exceed the EPA threshold for investigation (300 parts per million), and the upper confidence limit for 1994 exceeded the threshold only slightly.

According to the NSW Roads and Traffic Authority (RTA), a daily average of 14,400 vehicles have used the M23 motorway since it opened.

Discussion

The results of the surveys indicate that the burden of lead in the school population and the school environment did not increase over the first year after the motorway was opened. There are three possible explanations for this finding.

- Significant lead pollution of the school environment did not occur. A daily average of fewer than 15,000

TABLE 1

ENVIRONMENTAL SAMPLES FROM THE SCHOOL – LEAD CONTENT IN PARTS PER MILLION, 1993 AND 1994

Sample # and Type	Result (ppm) (µg/g)	
Date	15 July, 1993	11 August, 1994
1. Soil 320 130		
2. Soil	160	Not available
3. Soil	25	65
4. Soil	50	30
5. Soil	30	375
6. Dust	660	450 (only 0.02µg/dl sample)
7. Soil	30	45
Average	182.14	182.50

* Note: Results in µg/dl may be converted to µmol/l by dividing by 20.714.

cars does not represent heavy traffic, and about half the vehicles were likely to have been using unleaded petrol. Furthermore, the RTA had built physical barriers between the school and the road in the early stages of the motorway's construction to minimise the potential impact of visual, noise and air pollution. Fortunately, the local topography enabled the road surface to be some metres below the level of the school grounds, and hidden from view by a 3m high timber fence and trees planted on the roadside embankment. The trees were about 3m tall in 1993 and 4-5m in 1994. Any lead emitted from motor vehicles was probably restricted in its fall to the immediate vicinity of the roadway and would not have become sufficiently airborne to settle on the school side of the fence, thereby causing little or no pollution in the school grounds.

- Significant lead pollution did occur, but the study did not detect it. The response rates of 60 per cent in 1993 and 65 per cent in 1994 were disappointing. However, it was unlikely that the blood lead levels of non-participants would have risen more than those of participants.

The environmental sampling was on a small scale. A more comprehensive sampling schedule would have had more power to detect a difference in environmental lead between 1993 and 1994, if a real difference had existed. However, the mean soil and dust lead levels for 1993 and 1994 were so similar as to make it unlikely that a major effect was missed.

- It is possible (but unlikely) that the follow-up survey was conducted too soon after the initial survey and that a longer follow-up period would have shown a different pattern.

Questions about accumulated lead could be addressed by serial blood lead and environmental lead surveys at the school. More information on environmental pollution could be obtained by measuring air lead levels with a high-volume sampler. However, such surveys seem unwarranted in this setting.

Lyngbye et al[3] and von Schirnding et al[4] have found that proximity of schools or residences (respectively) to heavy traffic was associated with higher blood lead levels in school children. We plan to assess the dose-response relationship in children living or attending schools near main roads, using data from more than 2,100 children whom we have tested in the Hunter area since 1991.

The present investigation was carried out in response to community concern. It was an efficient way to examine the impact of a new motorway on children's and environmental lead levels. The methods used could be applied in another setting should the public health need arise.

ACKNOWLEDGMENTS

We wish to acknowledge Mr John James and Ms Amanda Evans, HPHU Environmental Health Officers, who collected the environmental samples; the HAPS blood collection service; Ms Chris Harvison, Mr Randall Robertson, Ms Kim Jardim and Ms Christine Cowie for their advice and assistance with this article; and the laboratory of Pasminco Metals-Sulphide at Boolaroo for the soil and dust analysis.

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