Factors Influencing Exposure of Children to Lead

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Lead poisoning in children occurs when three conditions have been satisfied: a source of lead-containing material is accessible to the child, the material has been ingested, and the absorbed fraction exceeds that deposited in bone and excreted during a similar period. The source material is usually domestic paint, and in 70% of cases in one series this was indoor paint, particularly that applied to window-sills (Baetjer, 1959). Surveys intended to detect abnormal exposure of children have used the clinical history, blood and urine lead levels, basophilic stippled cell count, excretion of δ -aminolaevulinic acid, and the faecal excretion of lead (Barltrop, 1967, 1968, 1969; Barltrop and Killala, 1967; Chisolm and Harrison, 1956; Griggs *et al.*, 1964). Most of these studies have experienced difficulties in large-scale application, and because of the extended range of 'normal' have not proved to be efficient screening instruments. A further problem is that tests based on the chemical effects of lead *in vivo* require that the lead has first been absorbed before an abnormal result is obtained. It would obviously be preferable to measure risk or potential exposure rather than to detect the results of exposure. Children with pica are at greater risk than others, but this practice is so common in the age-group 1-5 years that it has little value for screening purposes (Barltrop, 1966).

Children of families of a low socio-economic group who inhabit old, poorly maintained properties are thought to be especially liable to lead poisoning (Byers, 1959), but these conditions are too widespread to be suitable for population screening. The direct approach to the problem, namely the analysis of paint samples from the child's environment, has attracted little interest, and analyses are usually made only after a poisoning has occurred for confirmation of the source. Knowledge of the lead content of paint in the homes of young children would allow the possibility of preventative measures being applied to potentially hazardous situations.

Conversely, the actual risk associated with children inhabiting homes containing lead paint is unknown.

This study was made in an area in which lead poisoning was known to occur, the homes were of widely varying age, and the inhabitants belonged to a wide range of social class. The efficacy of the faecal lead method for the detection of abnormal ingestion of lead had already been evaluated in the same district, with some positive findings (Barltrop and Killala, 1967), and a close liaison existed with the local health authorities. The investigation was intended to measure the lead hazard for a group of children in the study area in terms of the lead content of the paint most accessible to them, and to relate the findings to the age of the dwelling and the social class of the family.

Methods

The families selected for study were contacted at a single local Infant Welfare Clinic by two interviewers, and the sole criterion for inclusion was that the family contained at least one child aged 1 to 5 years. The selections were made consecutively from those attending, and were irrespective of the age of the child actually attending the clinic. Each mother was interviewed, and a proforma completed on which was recorded the size of the family group, the occupation of the head of the household, the number of children aged 0-14 years, and other information concerning pica and the duration of occupation of the household, which will not be reported here. After interview, permission to visit the house to obtain paint samples was obtained.

Samples of paint weighing approximately 30 mg. were obtained at each house visit using disposable stainless steel scalpel blades. They were taken from two sites in the room which was that principally occupied by the children. The sampling areas were: (a) the windowsill, and (b) one other painted surface in the same room at window-sill height.

After each house visit the age of each property was determined in collaboration with the Local Authority Planning Department. The social class was determined, using the scheme of the Registrar General.

Chemical analysis was performed, after wet digestion of representative samples weighing 1-5 mg., on suitable aliquots of the acid soluble residue by a semi-automated alkaline dithizone method (Browett and Moss, 1965).

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TABLE I
Distribution of 56 Homes by Age-group

Year and Number of Homes Built		
1965-1930	1880-1855	pre-1855
17	18	21

Findings

From the 56 homes visited 108 samples of paint were obtained. The households contained 69 children aged 1-5 years and 103 children aged 0-14 years. The age of the households fell almost equally into three groups 1930-1965, 1855-1880, pre-1855, and though this was fortuitous, it reflected the known pattern of house building in the district (Table I). The families were widely distributed through the social classes, but the numbers of class I and class V families were small (Table II), so that this limited the value of the conclusions that might be drawn with respect to variations between the extremes of social class.

Chemical analysis of the paint samples gave a range of lead concentrations of 0-40%. Though 53% of the samples contained more than 1% of lead, 25% of them contained more than 5% (Fig. 1). These levels were chosen for their relevance to current regulations concerning the lead content of indoor paints, and the special labelling of paints with high lead content. These figures referred to numbers of samples and not to households, though in almost all cases each home provided 2 paint samples for analysis.

The distribution of the 103 children aged 0-14 years was examined with regard to the age of the house occupied and the maximum lead content of the paint to which the children were exposed

FIG. 1.—Lead content of paint, 108 samples from 56 homes.

TABLE II
Distribution of 56 Families According to Social Class

	Social Class				
	I	II	III	IV	V
No. of families	6	14	15	16	5

(Fig. 2). Children inhabiting homes built between 1930 and 1965 were mostly exposed to paints with less than 1% of lead, and conversely children inhabiting pre-1855 homes were exposed to paints containing 5% lead. But this relation was not absolute, some high lead content paints being found in houses built after 1930 and some low lead values in paint from old houses. Data for the 69 children aged 1-5 years gave an essentially similar picture.

The distribution of children according to social class and maximum observed lead content revealed no apparent relation. This should be interpreted in the light of the distribution of children between the social classes in the population sample, since few children belonged to classes I and V. The distribution of paints, as opposed to children, was studied in a similar manner, and a clear demarcation between the 1880 and 1930 groups of paints emerged (Fig. 3). Though post-1930 paints had a lower lead content than those from the preceding periods, 25% of those paints had a lead content in excess of 1%.

The lead content of paint was correlated with the social class of the family, and the mean, 90th centile, and upper limit increased progressively as the social scale was traversed from class I to V (Fig. 4). This contrasted with the distribution of

FIG. 2.—Distribution of 103 children aged 0-14 years according to age of dwelling and maximum lead content of paint.

FIG. 3.—Distribution of 108 paint samples according to age of dwelling and lead content; mean (●), range (|), and 90th centile (—).

children between the social groups with regard to the maximum observed lead content of the paint, and the difference between the numbers of children in each class. The progressive nature of this trend, in spite of the limitations of sample size, was noteworthy.

Discussion

More than half the homes visited in this study had paint accessible to children, which contained more lead than is currently recommended for paint sold for indoor surfaces, though paint manufacturers in this country are not compelled to adhere to the recommended levels. There are special provisions concerning paint for children's toys and nursery furniture, but the lead content of paints applied to indoor surfaces is not controlled. Similarly children who have been poisoned with lead may have to be returned to their original environment without any effective measures being available to prevent recurrence.

The clear relation between the age of the property and the lead content of the paint samples taken from it suggests that high levels are associated with old paint previously applied. The interval from 1880 to 1930, when there was virtually no new building in the district, allowed comparison of pre- and post-1930 paints. The high lead content of paint in the older houses probably represented the residues of paint applied at least 39 years previously, though they were probably applied during even earlier periods, this could not be proved. The practice of repainting surfaces without the complete removal of the old paint results in the preservation of the original layers under a film of new paint. This also results in an increase in the thickness of the paint film, so that flakes of small surface area may

FIG. 4.—Distribution of 108 paint samples according to social class of family and lead content of paint (mean, range, and 90th centile).

attain an appreciable weight; a 10 mg. flake may easily contain 1 mg. lead (10%) and yet be little larger than a match head (Bartrop, 1968). The complete abolition of the sale of lead paints would probably not affect the hazard that already exists.

These studies refer to a small district of London in which up to 6 cases of lead poisoning occur per annum. The area is not unique in its allocation of 19th-century housing, neither can it be supposed that the pre-1930 paint used differed greatly in composition from that in other regions. Data from the Hospital In-patient Enquiry (HIPE) suggests, on the basis of a 10% sample of admissions to hospitals in England and Wales, that there are about 140 diagnoses of lead poisoning in children per annum (W. A. Wilson, 1968, personal communication), whereas from our experience up to 2000 diagnoses per annum might be expected. It seems that different diagnostic criteria apply in different areas, which might in turn reflect the availability of the necessary diagnostic aids, such as the determination of blood lead and urine coproporphyrin.

The relation between the lead content of the paint in a house and the social class of the family occupying it is difficult to explain, but might reflect the frequency of repainting or the inappropriate choice of paint. The lead content is not the only factor that renders a painted surface hazardous, the state of repair of that surface is also important. Flaked or peeling paint that can easily be dislodged by children is dangerous especially if supervision is inadequate. These factors may be especially relevant among some class V families, and the existing hazard of a high lead content paint may thus be enhanced.

Lead poisoning, with its sequelae of death and

permanent cerebral damage, could be eradicated. New legislation governing the content of lead in paint would be unlikely to influence the problem for a considerable period, and only measures designed to detect and remove lead paint already *in situ* in the child's environment are likely to be effective.

Summary

Paint samples from 56 homes of 103 children aged 1–14 years were obtained. The lead content of the samples was related to the age of the building and to the social class of the family; 53% of the samples contained more than 1% of lead. Old houses, and families of low social class, were frequently associated with indoor paints of high lead content. Lead paint applied several decades ago, even if infrequently covered by other paint, may still continue to provide a potential hazard. Detection and removal of lead paint already *in situ* should therefore be the aim in preventing lead poisoning of children from this source.

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