Selective Screening for Lead Poisoning in an Urban Teaching Practice

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The Commission on Chronic Illness defines screening as "the presumptive identification of unrecognized disease or defect by the application of tests, examinations, or other procedures which can be applied rapidly."[1] Although the concept of early case finding is attractive and has received widespread endorsement and application, several commentaries have appeared which question the utility of indiscriminant or universal testing.[2-4] Rather than mass, multiphasic screening, a more rational and cost effective approach may be that of selective screening of population subgroups as defined by those parameters indicative of particular risk.

Wilson and Jungner have suggested the following relatively specific criteria by which effective screening measures may be determined:

1. The condition being sought should be an important health problem for the individual and the community;
2. There should be an acceptable form of treatment for patients with recognizable disease;
3. The natural history of the condition, including its development from latent to declared disease, should be adequately understood;
4. There should be a recognizable latent or early symptomatic stage;
5. There should be a suitable screening test or examination for detecting the disease at the latent or early symptomatic stage, and this test should be acceptable to the population;
6. The facilities required for diagnosis and treatment of patients revealed by screening programs should be available:
7. There should be an agreed policy on whom to treat as patients;
8. Treatment at the presymptomatic, borderline stage of a disease should favorably influence its course and prognosis;
9. The cost of case finding (which should include the cost of diagnosis and treatment) needs to be economically balanced in relationship to possible expenditure on medical care as a whole: and
10. Case finding should be a continuing process, not a "once and for all" project.[5]

Although few disease states completely meet the rigid standards delineated above, determination of blood lead levels in selected populations fulfills most, if not all, requirements for a valid screening test. The adverse consequences of untreated lead poisoning include serious nervous system injury or renal damage[6,7]: in addition, subclinical lead poisoning may be a factor in the etiology of mental retardation,[8] susceptibility to infection,[9] and behavioral disorders.[10] Therapy, by chelating agents, and prevention, by reduced exposure to environmental sources of lead, are available for individuals with abnormally elevated blood lead levels.[11] Particularly at risk for increased ingestion of lead are children under age seven years, in whom pica and/or normal mouthing behavior play an important role.[12] For this high-risk population, the primary source of oral lead has been determined to be paint chips from older, poorly maintained residences.[13] Overt manifestations of symptoms appear to be seasonal, with over 70 percent of all toxic episodes occurring during the summer months.[12] The presymptomatic state can be diagnosed with a simple, inexpensive, acceptable capillary blood test.

In the past, much detection of presymptomatic lead poisoning has been accomplished by public health agencies through screening programs at inner-city day care centers and nurseries. How-

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Table 1. Center for Disease Control Criteria for Lead Intoxication

Class	Circulating Levels	
	Lead (μg%)	Erythrocyte Protoporphyrin (μg%)
I— Normal	29	59
Ia—Probable iron deficiency	29	60-189
Ib—Probable transient or declining lead level	30-49	59
II— Minimal elevation	30-49	60-109
III—Moderate elevation	50-79	110-189
IV—Extreme elevation	80	190

ever, the family physician who is aware of the problem can offer a similar service to that segment of his practice not reached by local agencies.

A pilot project, initiated in 1975 at the Rochester Family Medicine Program, provided lead screening for all practice patients of ages one to six years. Outreach measures, including letter, telephone, and home visits, were shown to effectively increase the numbers of children available for screening (34 percent of at-risk population screened in outreach group vs 21 percent screened in group not subjected to outreach measures).[14] Elevated levels of lead were most frequent in children under age seven years who resided in low-income urban neighborhoods.[15] Follow-up of abnormal screening results is frequently difficult for physicians to accomplish under ordinary circumstances.[16] The at-risk population for lead poisoning is a particularly difficult one with which to maintain ongoing contact. Such continued contact is essential to monitor sequential blood levels in borderline cases, and to evaluate the effects of remedial measures, such as direct medical intervention and/or government authorized abatement programs for lead contaminated housing.

For these reasons, the second phase of this program's lead screening project was initiated using a paramedical technician who was assigned as lead screening coordinator. This individual, partially supported by the County Health Department, worked closely with that agency, patients, and physicians-in-training to assure adequate follow-up of abnormal results.

This communication describes results of this second phase of a health maintenance/surveillance/educational program in a family medicine residency training setting which has detected and followed significant numbers of children with elevated blood lead levels, and which has contributed to resident physician understanding of the techniques and problems of selective screening and surveillance.

Methods

The Rochester Family Medicine Program is a private, nonprofit teaching practice with a staff of 7 full-time and 4 part-time faculty and 38 residents who receive their ambulatory training in a facility which serves over 11,000 patients. The demographic characteristics of the population and the record and data systems have been described in detail elsewhere.[16] Selection of patients was facilitated by a previously described system of filing family charts by area of residence.[17] Children

Table 2. Initial Screening Results: Age Factors

Age (years)	Total Screened (number)	Class I	Class Ia, Ib, and II	Class III
			number (%)	
<2	78	57 (73)	17 (22)	4 (5)
2-4	172	131 (76)	24 (14)	17 (10)
4-6	188	149 (79)	26 (14)	13 (7)
>6	91	74 (81)	11 (12)	6 (6)
Total	529	411 (78)	78 (15)	40 (7)

of ages one to seven years residing in those census tracts designated as "lower to middle" socioeconomically were offered free screening when seen for an office visit or when parents were contacted by letter, telephone, or home visit by the lead screening coordinator. Initial screening was accomplished by finger-prick blood lead determination; confirmatory venous blood determinations were performed on those with elevated levels. Both blood lead and erythrocyte protoporphyrin were measured. Toxicity was determined by a classification developed by the Center for Disease Control, Atlanta, which ranged from I to IV, with I being nontoxic levels and IV being "extremely elevated"[18] (Table 1).

Responsibilities of the lead screening coordinator included:

1. Offering screening tests to all children aged one to seven years who resided in the designated census tracts, or at the request of the attending physician or child's family.
2. Outreach to nonvisiting at-risk children by letter, telephone, or home visit.
3. Establishment and maintenance of a file of all children screened, giving demographic data and test and follow-up results.
4. Follow-up of children with elevated blood lead and/or free erythrocyte protoporphyrin levels.
5. Furnishing residents (physicians of affected children) with information on the proper investigation and therapy of affected children.
6. With physicians, notifying local agencies responsible for inspection of homes and abatement of contaminated premises.
7. With physicians, education of parents about sources of lead ingestion.
8. Production of required reports to governmental agencies on numbers of affected children.
9. Attendance at meetings of the County Lead Advisory Board.
10. Liaison with other lead screening programs in the community.

Results

A total of 529 children were screened over a period of three years. Included were 281 males and 248 females, primarily between the ages of one and six years. Tables 2 and 3 give initial results from finger-prick blood analyses for lead. No differences in the incidence of elevation of circulating lead which could be attributed to sex or race of the subjects were noted nor were any Class IV elevations observed. Prevalence of lead levels in excess of 30 μg/100 ml showed consistent decrease with age: from 21/78, or 27 percent of children less than two years, to 17/91, or 17 percent of children aged six years and over. Socioeconomic level, however, appeared to be a far more important determinant of potential lead toxicity than age. As shown in Table 3, Class II or Class III elevations were found in only 5/74, or six percent of children

Table 3. Initial Screening Results: Socioeconomic Factors

Socioeconomic Level	Total Screened (number)	Class I	Class Ia, Ib, and II number (%)	Class III
Upper	74	69 (93)	4 (5)*	1 (1)*
Middle	206	159 (78)	30 (15)	15 (7)
Lower	249	184 (74)	44 (18)	21 (8)
Total	529	410 (78)	78 (15)	37 (7)

*P<0.001

residing in census tracts designated "upper" socioeconomically, while "middle" and "lower" socioeconomic group children evidenced rates of 22 percent (45/206) and 26 percent (65/249), respectively (P< 0.001). Each physician-in-training was primary provider for an average of ten screened children, and all but two residents cared for one or more children with elevated circulating lead levels and were directly involved in attempted surveillance and remedial abatement measures or therapy.

Detailed study and follow-up surveillance was maintained on children from middle and lower socioeconomic groups who were screened subsequent to employment of the lead screening coordinator. Methods of contact with families of the 195 children thus screened are given in Table 4. Although screening at routine visit and outreach measures as a whole contributed the largest numbers of children tested, physician initiated request and outreach by home visit were significantly more effective than other methods in uncovering children with elevated blood lead and/or erythrocyte protoporphyrin levels (P< 0.001).

Table 5 gives the age and classification of elevation of all patients screened in this second, more detailed study period. Forty-one of 195 children were determined to be at potential or documented risk for severe lead intoxication. Children classified Ia and Ib were followed whenever possible since their potential for development of serious lead intoxication is high. However, as shown by Table 6, this at-risk population is outstandingly mobile and difficult to locate. Of the 19 children available to follow-up by the 17 resident physicians directly involved in their care, 18 showed sustained decrease in circulating lead levels following instruction to families and inspection of homes with subsequent abatement of contamination where indicated.

Discussion

Institution of a program of selective screening for potential lead intoxication has proven to be of twofold benefit. All families of children at risk have become aware of the serious hazards of excessive lead ingestion through explanation at the time of screening, and those with children evidencing abnormalities have become aware of remedial measures which may be undertaken at no personal cost.

Although employment of a lead screening coordinator is not appropriate for all primary health care sites, practices that serve large numbers of children from low socioeconomic neighborhoods can effectively use such an employee. In smaller practices a nurse or mid-level provider can be assigned the functions of case detection and follow-up of appropriate patients as part of his/her duties. In either case the multiple tasks that derive

Table 4. Method of Patient Contact for Lead Screening

Contact Method	Total Screened (number)	Total Elevated (number)	Percent Elevated (%)
Routine office visit	89	15	16.9
Request by:			
Physician	26	9	34.6*
Mother	2	0	—
Health department	5	0	—
Subtotal	33	9	27.3
Outreach by:			
Home visit	35	12	34.3*
Other (telephone, letter)	38	5	13.2
Subtotal	73	17	23.3
Total	195	41	21.0

*P<0.001

Table 5. Phase Two Screening Results: Age Factors

Age (years)	Total Screened (number)	Circulating Lead (number)			
		Class Ia	Class Ib	Class II	Class III
>2	22	0	1	2	0
2-4	70	3	8	3	4
4-6	65	0	5	6	0
<6	38	1	3	5	0
Total	195	4	17	16	4

from screening and case identification are more apt to be accomplished if the responsibilities are shared.

The program has provided, as well, an important learning experience for family medicine trainees. All resident physicians have, through active participation in this project, gained knowledge concerning the physiologic mechanism of heavy metal intoxication. They have also developed those insights into the problems of screening and surveillance which can seldom be achieved by means other than practical application or preventive principles. Although numbers of children available for follow-up were discouragingly low,

Table 6. Follow-Up Status of Children at Potential or Documented Risk for Lead Toxicity

	All number (%)	Circulating Lead Class Ia	Class Ib	Class II	Class III
		(number)			
Active	19 (46.3)	3	7	7	2
Lost to follow-up*	22 (53.7)	1	10	9	2
Total	41	4	17	16	4

*Unavailable six months following detection of elevated lead and/or erythrocyte protoporphyrin levels

resident physicians developed a more realistic attitude concerning the health behavior of this at-risk segment of their practice populations.

Most importantly, as a teaching device, this project has familiarized trainees with the benefits of appropriate use of paramedical personnel and the mechanisms involved in timely utilization of community health agencies.

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