Lead in the Inner Cities

Policies to reduce children's exposure to lead may be overlooking a major source of lead in the environment

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In the middle of the 1970s, U.S. health officials identified what some called a "silent epidemic." They were referring to childhood lead poisoning, a problem that is easily overlooked and underappreciated. Of all the metal-poisoning episodes to date, none has come close in sheer numbers. Toxicology textbooks mention cadmium poisoning in Japan in the 1950s and methyl mercury poisoning in both Japan in the 1950s and Iraq in 1972. Some hundreds of deaths were attributed to each of these events. But most textbooks fail to mention lead poisoning, in spite of the fact that since the 1920s millions of American children have been quietly poisoned by lead, and thousands of deaths are attributed to this over the long term.

Although childhood lead exposure has diminished over the past 20 or so years, the problem has by no means been solved. Rather, the demographics have shifted. Some groups, mainly minority and poor children living in the inner city, suffer from high rates of lead poisoning. Over 50 percent (some studies place this figure at around 70 percent) of children living in the inner cities of New Orleans and Philadelphia have blood lead levels above the current guideline of 10 micrograms per deciliter (μg/dL). In contrast, in the concrete jungle of Manhattan, where very little of the soil is exposed and almost all apartments and housing contain lead-based paints, between 5 and 7 percent of children under the age of 6 have been reported to have blood-lead levels of 10 μg/dL or higher. Interestingly, just across the river in Brooklyn, where yards containing soil are common, the percentage of affected children is several times higher.

Exposure remains such a problem that early in the 1990s, the U.S. Centers for Disease Control and Prevention (CDC) in Atlanta called lead poisoning "one of the most common pediatric health problems in the United States today," but added that the problem was "entirely preventable." Effective prevention, however, assumes an accurate identification of the environmental reservoirs of lead.

Current policies to reduce lead exposure are based on the assumption that the greatest lead hazard comes from lead-based paints. Poorly maintained paints decay and release lead on their surfaces in the form of dust. In addition, lead tastes sweet, and young children may be tempted to eat leaded paint chips as though they were candy. The health consequences of this can be severe. Lead is a neurotoxin that can be especially dangerous to the developing nervous systems of infants and young children. To deal with this problem, most lead paints have been removed from the market, some lead paints are being stripped off of walls, and parents are instructed to guard their children from eating paint flakes.

But such policies deal with only part of the lead hazard. Work done in my laboratory demonstrates that there exist additional sources of lead in the environment that pose as great, if not greater, threats to children. To be sure, lead paint is a major contributor of the lead in the environment. Lead was used in residential paint between 1884 and 1978 and remains on the walls of many older buildings. But paint is neither the most abundant nor the most accessible source of lead. The common problem is lead dust. For most children the issue is whether there is a source of lead dust in the environment. Research in my laboratory and others shows that in predictable locations of many cities, the soil is a giant reservoir of tiny particles of lead. This means that many children face their greatest risk for exposure in the yards around their houses and, to a lesser extent, in the open spaces such as public playgrounds in which they play. My colleagues and I believe that an accurate and complete appreciation of the distribution of lead in the environment can help shape policies that more effectively protect the health of children.

Sources of Lead
Lead is versatile and formulated into many products. Some products, such as common lead-acid batteries used in cars, trucks, boats, motorcycles and the like, are sealed and if appropriately recycled, should not be the cause of
poisoning of ordinary citizens. Other products allow lead to be released into the pathway of human exposure. Lead solder was used to seal seams in the canning industry until it was voluntarily withdrawn, first from baby food containers and then all canning facilities in the early 1980s. The same canning solder is used in other countries, and imported canned food continues to be tainted with lead. Some brightly colored ceramic plates and cups as well as leaded crystal may, in the presence of acidic foods (tomatoes, pineapple, wine etc.), release lead and contaminate the food. Lead-based paint was banned for household use in 1978, but lead is still an ingredient of “specialty” paints. Lead-free gasoline was banned in 1986, although lead additives are still in use in racing fuels (up to 6 grams per gallon), boat fuels, farm tractors and personal watercraft fuels despite the fact that they are not required in any of these applications. Alternative octane boosters are available.

Lead acetate, or “sugar of lead,” is water-soluble and one of the most bioavailable forms of lead. It is an ingredient in some hair-coloring cosmetic products. The Food and Drug Administration allows up to 6,000 parts per million of lead acetate in cosmetics. Several brands of slow-acting hair-coloring cosmetics are used daily by a sizable number of people with graying hair in many homes both in the U.S. and abroad. When users pour the cosmetic into their bare hands to rub into their hair, they become conveyers of a very toxic substance. Some lead acetate may be spilled on the sink, and it is indistinguishable from drops of water. On the hands it can be easily transferred to other items such as toothbrushes, faucet handles, combs and dental floss. It can be absorbed through the skin and shows...
Figure 2. Bare soils in play areas, especially those near busy roads, constitute one of the most common vectors by which children become poisoned. Children play in these soils, put their hands in their mouths, or touch objects that do, and ingest the lead. Children are most vulnerable to the toxic effects of lead, which include damage to the nervous system, learning impairments and behavioral problems.

up in sweat and saliva, but not in blood, as does ingested lead. Many plastics and vinyl products contain lead as a stabilizer or coloring agent. Products become a hazard if they deteriorate into fine dust particles or otherwise directly release lead onto hands (or paws), from which it is transferred into the mouths of unsuspecting creatures, including people.

Lead in paint and gasoline together accounts for most of the lead now in the human environment. In terms of raw tonnage, the amount of lead in gasoline over only the 57 years of its use from 1929 to 1986 roughly equals all of the lead in paints in 94 years of lead-paint production, from 1884 to 1978. The peak use of lead-based paint came during the 1920s when the U.S. economy was largely agrarian and rural. Most lead paints still exist as a thin mass on the walls and structures of older buildings. Deteriorated or sanded and scraped paint contributes to lead dust accumulation in the soil.

In contrast, the use of leaded gasoline peaked early in the 1970s, a time during which the U.S. economy had become industrial and urban and reliant on automobiles for transportation. About 75 percent of gasoline lead was emitted from exhaust pipes in the form of a fine lead dust (the remaining 25 percent of the lead ended up in the oil or was trapped on the internal surfaces of the engine and exhaust system). It is estimated that the use of 5.9 million metric tons of lead in gasoline left a residue of 4 to 5 million metric tons in the environment. From these facts, we expected to find that lead would be disproportionately concentrated along roadways with the highest traffic flows—those running through cities.
Health Consequences

Lead poisoning was known in colonial times and has roots in antiquity. Clinical symptoms of lead poisoning were observed in the work force of trades that handled lead. Benjamin Franklin noticed in 1786 that some of his lead type-setters at the print shop suffered from a debilitating weakness of the hands called cropsy. He observed that those workers who suffered from cropsy failed to wash their hands before eating their sandwiches, and attributed the disease to their slovenly and unclean habits. When he learned of a 60-year-old report noting similar health problems, he commented, “and you will observe with concern how long a useful truth may be known and exist before it is generally received and practiced on.”

The clinical problems of lead poisoning were described by the Greeks and were so prevalent during Roman times that some attribute the fall of Rome to lead poisoning of the aristocracy. It was considered a scourge (Saturnine poisoning) in Europe in the Middle Ages, when people frequently sweetened sour wine with lead acetate.

In other words, lead poisoning is not new, but because of the industrial way of life the poisoning has shifted to children, and the number of its victims has skyrocketed. Consider the magnitude of the man-made products that use and release lead into global environmental circulation. Jerome Nriagu of the University of Michigan School of Public Health estimates the total amount of lead produced from mines to be about 260 million metric tons in the past 3,000 years. And all of this mining has left its imprint in the geological record. Lead is found trapped in datable layers of the glaciers of Greenland, peat-bog cores of Switzerland and sediment cores of the Mississippi Gulf Coast. Although this geochemical perspective provides a framework for the history of the global quantity of mining and environmental emissions over three millennia, it does not assist us in appreciating the nature and degree of the local insult that lead has had on our urbanized society. The impact—particularly on children—was not fully appreciated until the past few decades.

Re-evaluations

Until the 1970s in the United States, the health guidelines for lead exposures were essentially the same for children as for adults. In 1979 guidelines for both the amount of lead and the differences in vulnerability between children and adults were revised when Herbert Needleman at Harvard Medical School reported that children's cognitive abilities were affected by much lower lead exposures than previously recognized.

At about the same time that Needleman was doing his work, my colleague Rufus Chaney and I were conducting a study at the U.S. Department of Agriculture in Beltsville, Maryland, of the lead content of garden soils in Baltimore, Maryland. While we were performing the field studies, supervisors and other people frequently reminded me that the major source of lead in soil is lead-based paint. When we pored over the results of our analytical determinations, we came up with a problem of statistics. The distribution of the numerical results did not follow a normal curve. The statisticians I initially worked with wanted to truncate the results so that they conformed to the normal distribution.

In essence, the highest numbers were being removed from the database to satisfy the re-

Figure 3. Lead use in paint peaked in the U.S. in the mid-1920s and then gradually died out, just as the use of leaded gasoline was on the rise. The use of leaded gasoline reached its peak in the 1970s and then declined until Congress banned it in 1986. There is a common perception that lead-based paints alone account for the amount of lead in the environment. In reality, both sources of lead contribute to the problem.

Figure 4. Car exhaust spewed lead particles into the air when leaded gasolines were used. Soils in areas with a long history of traffic congestion, such as the inner cities, are heavily contaminated with lead. Lead resists movement and does not decompose, so it remains a permanent feature of the environment until people take measures to deal with it.

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Figure 5. Two different-sized lead particles are spewed into the air when leaded gasoline is used. The trajectory of a typical particle is indicated by the blue arrows (top). Larger, heavier particles settle near the street. Smaller particles are carried by the wind until they meet a barrier, such as a tree or a house, to which they stick. Eventually, they are washed into the soil by rain. Lighter particles can be carried a greater distance and are eventually scavenged by precipitation and then fall to the ground. Assuming unpainted homes, the graph (bottom) generalizes the quantity of lead in the soil around an inner-city home situated about 7 meters from a heavily traveled road versus around a home more than 25 meters from the road.

requirements of the parametric statistical models being used at that time. My brother, Paul Mielke, is a professor of statistics at Colorado State University, and I called on him for help. Paul and Ken Berry, also at Colorado State University, had recently completed their work on a non-parametric statistical test, Multi-Response Permutation Procedures, which provided a method for testing the kind of data that I had.

Paul had an appropriate nonparametric statistical model but no data base to analyze; I had the data base with no model to evaluate it. Serendipity played a role in our initial realization about the extraordinary accumulation of lead in urban environments. The research results were surprising. The pattern of lead did not match what we expected to find if paint alone was the major source of lead in Baltimore soils.

Our data did not support the lead-based paint hypothesis. Our observation was that in the inner city, where the soil-lead concentrations are highest, Baltimore had mostly unpainted brick buildings, since its inner city underwent a huge fire in 1904. On reconstruction, the new building codes required the use of fireproof (hence, brick) construction materials.

The sites of old housing constructed with painted wood siding are located in outlying parts of the city, where the lead content of garden soils is lowest. The highest lead-containing garden soils appeared to be associated with the inner-city location, not the presence of painted wood structures. The geographic pattern was extremely strong. Because of this simple observation, I sought an alternative source of lead.

Leaded gasoline fit the requirements for that alternative. We learned that gasoline was a huge source of lead, and we predicted that it was exhausted in a pattern that corresponded to the flow and congestion of traffic. The environment of the city was undergoing lead accumulations because of the daily commuter traffic flows that strongly characterize the industrial way of urban life. We suspected that the lead particles released with gasoline exhaust could travel through the air until they hit a barrier, such as the side of a house or apartment building. We also imagined that these lead particles
would be washed down the sides of the buildings and into the soil anytime it rained. Based on this scenario, we would expect the greatest accumulations of lead to be found in the soil surrounding the foundations of buildings. We also thought it was possible that lead accumulated in soil was a major contributor to the childhood lead problem of Baltimore.

Our findings were published in 1983. Did the automobile act as a toxic-substance delivery system in all large cities? Critics of our publication argued that Baltimore is an unusual city because of all of the heavy industries there. They asserted that industrial emissions, and not leaded gasoline, accounted for the soil-lead accumulation problem in Baltimore. In 1979 I moved to Macalester College in St. Paul, Minnesota. I received a small grant to study St. Paul soils. The family of one of my students, Handy Wade of Boston, funded the purchase of analytical equipment to determine the lead content of soil samples. By 1984, the results were available.

We found that St. Paul and Minneapolis, where, in contrast to Baltimore, there is no heavy industry, had the same inner-city soil-lead accumulation as first observed in Baltimore. Even the quantities were similar. We also studied small towns and large cities and found that city size was a more important factor than age of city.

The soil-lead concentration in old communities of large cities is 10 to 100 times greater than comparable neighborhoods of smaller cities. In addition, soil-lead concentrations diminish with distance from a city center.

For example, in Baltimore, the highest garden-soil contamination is so tightly clustered around the city center that the probability that this distribution could be due to chance is 1 in 10^{23}. The concentration of lead in the soil of the Twin Cities (Minneapolis and St. Paul) is 10 times greater than that in adjacent suburbs that have old housing, where lead-based paint concentrations are as high. In 1988, I joined the faculty of Xavier University in New Orleans. I repeated the soil-lead studies conducted in Minnesota and obtained similar results. Soil-lead concentrations were higher in congested high-traffic, inner-city regions of New Orleans, as compared with its older suburbs and with smaller towns. Although the age of the houses in these communities is similar, the traffic flows vary widely. In New Orleans, with a population of about 500,000 people, the daily traffic count at major intersections in the inner-city averaged about 100,000 vehicles in 1970. In contrast, in a small town, such as Thibodaux, with its population of about 14,000, the busiest intersections averaged only about 10,000 vehicles a day in 1970. These data strongly suggested to us that proximity to a high-traffic route is a better predictor of soil-lead concentrations than is the age of the buildings in the area or the amount of lead-based paint in the buildings. We further speculated that the soil of larger cities is more concentrated in lead than is the soil of smaller cities because of the greater volume of traffic in larger cities and because each vehicle remains inside the larger city longer than it would inside a smaller city.

In New Orleans, we tested our hypothesis that soil-lead accumulations do indeed follow traffic volumes with a comparison of large versus small cities. To do this, my colleagues and I calculated the quantities of lead emitted within one-half mile of major intersections of the inner-city regions of New Orleans and Thibodaux using the average daily vehicle traffic records during the peak lead-use years. Both of these communities have older housing with lead-based paint located around the community core, but their traffic flows differ by a factor of 10.

Figure 6. Soil-lead concentrations are greatest in the soils of large cities, such as New Orleans, and lower in the soils of smaller cities and towns, such as Baton Rouge, Monroe, Alexandria, Lafayette and Natchitoches. Soil surrounding the foundations of houses and buildings is more heavily contaminated than are soils around the street or in open areas. (The 1990 population of each city is given below the city’s name.)
urban highways can be considered inadvertent dispersal systems of lead in densely populated areas surrounding the city center. Some people may argue that since lead has been removed from gasoline, it no longer poses a threat to children's health. But the clays and organic matter in soil weakly bind lead, and our research findings give us reason to believe that lead remains in the soil of the inner cities for a long time. Our results refute the commonly held notion that lead concentrations are highest in all areas with older housing.

**Children at Risk**

Lead is a neurotoxin that can be especially harmful to the developing brains and nervous systems of young people. High doses can be fatal. Chronic exposures to as little as 10 micrograms of lead per deciliter of blood can permanently impair the brain's functioning, thus limiting a child's intellectual and social development. It can also result in behavioral problems, which are disruptive to other children in the classroom.

The survey conducted in the 1970s showed that nine of eleven children in the United States had lead concentrations of 10 μg/dL or higher in their blood. By that time, lead-based paint production had been curtailed. Since that time, lead has been removed by mandate from gasoline and eliminated from food processing, so that a survey conducted late in the 1980s indicated that only one out of eleven children was exposed to dangerously high levels of lead. Surveys show, however, that the children affected now are disproportionately African-Americans living in the inner cities of major U.S. cities.

The Environmental Protection Agency (EPA) has estimated that more than 12 million children living within U.S. urban environments are exposed to risk from 10 million metric tons of lead residues resulting from the use of leaded gaso-
line and lead-based paint. A child can safely tolerate an intake of only 6 micrograms of lead per day. The mass of lead in America's urban environments that is potentially available to children is about 19 orders of magnitude \((10^{19})\) greater than safe levels. Clearly, there is an unacceptable amount of lead potentially available to children. In the laboratory we have attempted to measure how much lead is actually available to the child.

Children frequently put their hands in their mouths, and this is the most common route of exposure to lead. To get an idea of how much lead children routinely ingest, Latonia Vivette, then on staff at Xavier, and I measured the amount of lead on children's hands in New Orleans.

We visited several daycare centers in various parts of the city. Children's hands were wiped after they had played indoors only and then a second time after they had played outside. Our general conclusion was that children have several times more lead on their hands after playing outdoors than they do after playing indoors. The amount of lead varied directly with amount of lead measured in the outdoor soil. For private daycare centers located in ordinary homes with soil in the yards, the amount of lead picked up by children varied directly with the amount of lead in the yard soil. The amount of lead in the soil also related to the part of the city in which the daycare center was located. In the inner city, the children picked up the most lead, whereas in daycare facilities in the outer city, children were least exposed. We also observed that soil was absent from public Head Start daycare centers. The soil in outside play areas was completely covered with rubberized matting or other playground covering and did not contain bare soil. Even in the inner city, children at public daycare centers did not pick up appreciable amounts of lead on their hands.

In collaboration with Dianne Dugas and her staff at the Department of Environmental Epidemiology and Toxicology in the Louisiana Office of Public Health, we then looked at the age of homes and soil lead to determine how they related to children's blood-lead levels. Correlating the age of housing with blood-lead levels yields mixed results. In 96 percent of the areas where we found low levels of lead in children's blood, a majority of the houses were newer, having been built after 1940, when the use of lead-based paint had been reduced. By contrast, in areas where children had high levels

![Figure 9](Image)

**Figure 9.** Young children frequently put objects and hands in their mouths, by which they ingest lead-contaminated dust and soil.

![Figure 10](Image)

**Figure 10.** Measuring the lead on children's hands reveals that children pick up more lead when they play outdoors than indoors. This graph reflects data collected at private daycare centers at residential dwellings. The children of inner-city New Orleans (left graph) playing outdoors encounter as much as ten times the lead on their hands as children who play outdoors in non-inner city and suburban neighborhoods (right graph) around New Orleans.
of lead in their blood, 51 percent of the houses in these areas were built after 1940, and 49 percent were built before. Newer housing is a good predictor of low blood-lead levels, whereas old housing is a poor predictor for the group of greatest interest, children with high blood-lead levels.

The strongest correlation linked soil-lead concentrations and blood-lead concentrations, as we had expected. The association between soil lead and blood lead was 12 orders of magnitude \(10^{12}\) stronger than the association between the age of housing and blood lead levels. Soil-lead concentrations are more predictive of childhood lead exposure than is the age of housing. In New Orleans, housing tracts with low levels of lead in the soil are very strongly associated with low blood-lead concentrations, whereas areas high in soil lead are likewise associated with high blood-lead concentrations.

**Prevention**

During a routine check-up in 1983, my daughter Beverly, then about two, was found to have a blood-lead level of about 10 to 15 \(\mu g/dL\). I became haunted by the fact that my daughter and all other children were being poisoned, a finding that was reinforced by the 1978–83 national survey results. Given what I knew, I spent several days observing her activities and taking soil and paint samples. Her licensed day-care home was located several hundred yards from a major freeway. The state’s licensing inspection focused on the condition of the inside facilities. The sandbox where the children played daily contained a mixture of soil and sand, which was located next to the house and was surrounded by soil that contained over 500 parts per million of lead. I replaced the sand and laid down indoor-outdoor carpet on the bare soil around the sandbox. A month after I made these changes, Beverly’s blood-lead levels dropped by half. My daughter’s exposure riveted my attention to our nation’s lead problem.

This experience and the results from our work in Minnesota prompted the formation of the Minnesota Lead Coalition. Patrick Reagan, of the Midwest Environmental Education and Research Association, became a major coworker with the coalition. The lead coalition lobbied the Minnesota legislature to bar leaded gasoline. The effort failed because, unknown to us, additives to gasoline, as stated in the Federal Air Pollution Regulations, are the exclusive jurisdiction of the federal government. The only way that lead could be banned from gasoline was by EPA regulation or congressional action. Senator David Durenberger was on the subcommittee that conducted hearings to consider new lead regulations.

The Senate hearings took place in June of 1984, and I was invited to make a presentation on behalf of the Minnesota Lead Coalition. Our statement played a prominent role in the deliberations. Senator Durenberger apparently expected us to fully agree with and testify in support of the Senate bill that delayed banning lead in gasoline until the mid-1990s. We could not support this provision and instead testified in favor of the House version of the bill, which banned lead on January 1, 1986. Senator Durenberger stopped the hearing to publicly reprimand me for not testifying in support of the Senate bill. Nevertheless, the next speaker, from Ashland Oil Company, threw down his prepared statement and agreed with us about the January 1, 1986 date. He said that his company...
had tooled up to meet the demand for unleaded fuel and was now paying a large monthly sum to store their unused lead-free fuel refining capabilities. The rapid phase-down became law on January 1, 1986. Unfortunately, the automobile had already spread the toxin. It played a role as a toxic-substance delivery system.

It is important to note that during recent decades public actions for lead exposure prevention have concentrated on screening children for elevated blood lead and treating children on a case-by-case basis for lead poisoning. This is secondary exposure prevention because a victim must be identified before treatment can proceed. Treatment invariably focused on limiting exposure to lead-based paint, usually by removing it. But the treatment often resulted in the release of lead dust, which exacerbated the lead poisoning.

There have, however, been phenomenal gains in the reduction of children’s blood-lead levels for the whole population of U.S. children, most of the gains taking place even before the federal lead-based paint intervention programs were in place. Although the gains have been remarkable, nevertheless, the poisoning problem continues to plague our society.

Our studies have shown that for most urban areas, decades of leaded paint and gasoline use have resulted in the accumulation of lead in the soil. The major conclusion from our New Orleans study is that a balanced prevention program must include activities to limit exposure to contaminated soil.

The Federal Residential Lead-Based Paint Hazard Reduction Act of 1992 includes soil and dust as sources of lead. Nevertheless, in practice, these vectors are not adequately acknowledged as the dangers they are. For example, Patrick Reagan of the Minnesota Environmental Research Association has documented that only 9 of the 26 member countries of the Organization for Economic Cooperation and Development regulate lead in soil, as opposed to 17 members that regulate lead in paint.

This is certainly true in the United States, where there exist more programs to limit exposure to lead paint than to leaded soil. In recently submitted rules, the EPA proposes 2,000 parts per million as an acceptable standard for soil lead. For children, this is not a protective standard. In Sweden, the standard soil-lead concentration for play areas is 80 parts per million. As guest scientist to Stockholm, I saw first hand the thoroughness of the implication of the standard. The attitude of the people of Stockholm is that a city safe for children is a city safe for everyone.

The U.S. Department of Housing and Urban Development (HUD) proposes less stringent regulation for lead in soil (500–1,000 parts per million) than for lead in paint (600 parts per million). These proposals come in spite of the fact that HUD among other federal agencies concluded that soil and dust are important sources of lead. HUD notes that “for infants and young children ... surface dust and soil are important pathways....” The Agency for Toxic Substances and Disease Registry (ATSDR) specifically states that the two major sources of lead are paint and soil. And a recent CDC report states that “lead-
based paint and lead-contaminated dusts and soil remain the primary sources...." The EPA reports that "the three major sources of elevated blood lead are lead-based paint, urban soil and dust ... and lead in drinking water."

There are more than 20 other government reports that recognize the major hazards posed by leaded soil and dust. When, and only when, the sources and pathways of lead contamination are explicitly recognized as entwined will measures to prevent childhood exposure improve the situation.

Recognizing that soil in play areas is a major source of environmental lead provides an obvious course for prevention: Parents can provide a clean play area for their children and they can teach their children to wash their hands after playing outside. Communities might consider joining together to resurface play areas.

In Minneapolis and St. Paul a pilot project to reduce children's exposure to lead was implemented during the summer, when children spend the most time outdoors. In the target communities, children had their blood-lead concentrations measured at the beginning of the project in May or early June and at the end of the project in late August and September. Adults in this community were taught how to reduce the children's contact with bare soil. At the end of the trial, 96 percent of the children in the target community either remained the same or experienced decreases of blood lead, and 4 percent experienced modest rises. In contrast, children within a control community had their blood-lead levels measured, but no further education was provided. At the end of the trial 53 percent of these children experienced an increase in blood-lead levels, while 47 percent either remained the same or experienced decreases. Eighteen percent of the children in the control group had blood-lead levels of 40 µg/dL or higher, which necessitated clinical intervention. This contrasted sharply with the target group, where none of the children required clinical intervention.

A second study was conducted in Minnesota during the winter to evaluate the changes in blood lead when the ground is covered with snow and ice. The target group received special house-cleaning assistance, which the control group did not receive. Nevertheless, at the end of the winter both groups of children displayed the same degree of reductions in blood lead, relative to levels at the beginning of the winter, regardless of the cleaning treatment in their houses. This result further reinforces the hypothesis that outdoor soils are a major reservoir of lead.

The community of Trail, British Columbia, the site of the largest lead-zinc smelter in North America, provides an example of another community that successfully dealt with the problem of toxic levels of lead in its soil. Initially community leaders feared that alerting the public to the potential hazards of the soil would drive people out of the community. In spite of those fears, a primary-prevention program was put in place. Parents and child-care providers were educated about the problem, and contaminated soils were covered with plants or wood chips. New play boxes containing clean sand were put in play areas as an alternative to bare soil. Service organizations such as the Kiwanis Club, the Knights of Columbus and the Rotary Club joined to carry out landscaping projects on properties where parents could not afford to do it themselves. Because of these efforts, the levels of lead in children's blood dropped significantly 2 to 4 µg/dL (in three out of five years) or remained unchanged (during the other two years). These measures—particularly the new landscaping—had the added benefit of improving the community's overall appearance. Ultimately, the city even attracted an influx of new residents. Now all residents are routinely provided information about the lead problem and are educated about preventive measures.

The quantity of lead in New Orleans inner-city soils is about the same as that of the lead-smelter community of Trail. There is reason to believe that the success achieved by Trail could be repeated in other urban areas with contaminated soil. To reduce lead exposure of New Orleans children, I envision a program similar to Trail's. The major stakeholders include public
officials, community organizations, public health and health-care providers (including pharmacists who have daily and direct contact with customers), parents, teachers, church leaders, painters, homeowners and landlords. The overall goal would be to prevent children from exposure to lead dust and contaminated soil. The projects must include interior dust control combined with measures to prevent exposure to exterior soil hazards.

Lead paint can be prevented from entering the environment by preventing its unsafe removal from both interior and exterior surfaces of houses. Alternatively, surfaces coated with unsafe paints can be covered over with a physical barrier, such as wall board. Some New Orleanians painters have already agreed to use wet scraping and modern sanding equipment that captures the paint dust, rather than releasing it to the environment.

To reduce exposure from soil-based contaminants, the safest measure would be to prevent children from playing in bare soil, especially soil in play areas next to residential dwellings in the inner city. Soils should also be covered and maintained with a tilled or grass alternative surface, such as rubberized matting, bark, gravel, decking or cement. New Orleans has an enormous supply of river sediment that originates from farmlands upstream, which can be used to cover over the currently contaminated soils. In addition, lead-safe play areas, such as sandboxes, can be erected. These measures can be paid for by a tax on gasoline. A program to relandscape children’s play areas would also provide useful employment to city residents.

Ultimately, successful prevention programs can be achieved only through collaborative efforts that combine public education with community-based primary-prevention measures. These efforts must focus on the ideal of clean environments as a means to healthy communities. It took nearly 20 decades for lead to accumulate to its current levels in urban areas. With judicious planning, the problem can be resolved in much less time.

Bibliography

Links to Internet resources for further exploration of “Lead in the Inner Cities” are available on the American Scientist Web site: