SOURCES OF CHILDHOOD LEAD EXPOSURE

Lead enters the body through inhalation or ingestion. Although inhaled lead particles are rapidly absorbed by the body (40 to 50%), children are rarely exposed to high concentrations of airborne lead. Ingestion is the primary route of exposure for almost all lead poisoned children. This route of exposure to children is aided by mouthing activities, high gastrointestinal absorption rates (approaching 50%), and the relative abundance of lead contamination in the environment.

Lead-based paint is the most common source of high dose lead exposure for children. Lead was used as a pigment and drying agent in "alkyd" oil based paint. About two-thirds of the houses built before 1940 contain leaded paint. Lead-based paint continued to be used to a lesser extent until 1978 when the U.S. Consumer Product Safety Commission lowered the permissible lead content of house paint to 0.06 percent. Lead-based paint is still available for other purposes such as automotive and marine products. It is estimated that nationwide lead-based paint remains in 57 million occupied private housing units (74%) built before 1980. Many of the houses painted in the first half of this century contain heavily leaded paint (up to 50% lead by weight) in deteriorating condition.

Lead-based paint is typically found on kitchen and bathroom walls and throughout pre-1950 homes on doors, windows and wooden trim. Exterior surfaces generally exhibit higher lead contents than interior woodwork. The risk of lead poisoning is greater when lead-based paint or the underlying surface are in deteriorated condition and when lead-based paint (even intact paint) is located on surfaces accessible to children. Lead-based paint on interior and exterior window components is of particular concern because it becomes abraded into dust by repeated opening and closing of windows. In North Carolina, lead-based paint on exterior porches has been implicated as a high risk source of lead exposure to children. Children often play on porches that have chewable railings and porches were often painted with highly leaded paint.

Soil and dust are the primary routes of exposure to children for lead deposited by primary lead sources such as lead-based paint, leaded gasoline, and industrial or occupational sources of lead. Since lead does not dissipate, biodegrade, or decay, the lead deposited into dust and soil becomes a long-term source of lead exposure for children. Soil lead concentrations above 10,000 parts per million (ppm) have been found in surface soils around house foundations (paint deposition), along roadsides (historic auto emissions), and near smelters (industrial emissions).

Children often play in soil near houses and other buildings. As part of normal play and hand-to-mouth activities, children ingest lead from soil or dust. Many children eat dirt and can be exposed to high levels of lead from contaminated soil near house foundations and particularly near porches where paint flakes have been swept off. Contaminated soil may also be tracked into the house and add to lead contamination of house dust that is also often contaminated by deteriorating paint inside the house. Dust lead levels are generally much higher than soil lead levels and house dust can easily be ingested by small children. Dust that collects in window troughs is another significant source of highly contaminated dust accessible to small children. There have been a number of childhood lead poisoning cases attributed to lead-contaminated dust brought home on the work clothing of parents who are occupationally exposed to lead-contaminated dust. Remodeling activities and burning of lead painted wood can also increase the lead content of interior house dust.

Occupational lead exposure can result in lead exposure to workers' children if proper control measures are not used to prevent the spread of lead contamination into children's environments. Workers in many occupations are exposed to lead-contaminated dust or fumes that may be carried home on work clothing and contaminate their home environment. Childhood lead poisoning cases in North Carolina have been linked to occupational exposure of parents who are

painters, paint strippers, battery recyclers, auto salvage workers, battery service workers, ceramics makers, or lead smelters. A more complete list of occupations involving lead exposure is included in the appendix.

The Occupational Safety and Health Administration (OSHA) has developed general industry standards for control of workplace lead exposure. Although the enforcement of those standards controls exposure from many of the primary lead-using industries, workplace exposures are common in many industries involving secondary exposure to lead-containing products and in small shops that often escape detection by OSHA inspectors. The OSHA general industry standards for lead do not apply to the construction trades where lead exposure is common. Lead exposure in the construction trades went unregulated until May of 1993 when OSHA first adopted standards for lead exposure to construction workers.

Lead smelters produce difficult to control lead emissions. Heating lead to temperatures above 500°C (900°F) causes lead to fume. Lead fumes are of such a small particle size that they become airborne and attach to everything including workers' clothing. Worker protection and contamination control measures are often ignored or unknown at small smelters involved in recycling lead scrap. Workers often know nothing about the hazards of lead. One smelter in eastern North Carolina involved in the manufacture of fishing weights was responsible for contaminating a home and poisoning several children. Soil at one smelter site located in a mobile home park was found to contain 498,000 ppm lead.

Battery manufacture, repair and destruction is another industry where heavy lead exposure can occur. Lead acid battery manufacture is the largest industrial use of lead. While the manufacturing process is often closely regulated, smaller shops that service batteries are at high risk of contaminating workers and their children. Children in North Carolina have been poisoned as a result of exposure to lead-contaminated dust brought home on the clothing of battery service workers, by soil contaminated with lead from a battery cracking operation, and by lead fumes generated by burning battery casings in a wood stove.

Automotive repair and salvage is another industry where lead exposure can occur, often without the workers being aware of it. Auto bodies, batteries, radiators, and electrical parts often contain lead. Children in North Carolina have been poisoned as a result of parent's exposure to lead from stripping paint off of car bodies and auto glass, and from recycling batteries. High lead levels can be found in soil at auto salvage yards. Workers at radiator repair shops who disassemble and reseal lead solder joints are often exposed to lead-contaminated dust and fumes.

Construction workers, including sand blasters and painters may be exposed to high concentrations of lead-contaminated dust from paint removal or demolition at older buildings and steel structures. Most steel structures have been painted with lead-based primers or paint and workers involved in paint removal or repair on those structures may become contaminated. Welders are exposed to lead fumes when cutting or welding lead painted steel. Sand blasters can generate huge quantities of lead-contaminated dust and paint chips. Painters are often contaminated with lead paint dust while scraping old paint and lead fumes when using heat guns for paint removal. A number of children have been poisoned in North Carolina as a result of careless or uninformed painting contractors or homeowners involved in home renovation. Most paint removal techniques generate lead-contaminated dust. The use of heat to remove lead-based paint is particularly troublesome if paint is heated enough to produce fumes that can contaminate a home and may be impossible to clean up.

Parents with **hobbies** involving the use of lead may unknowingly poison their children. Commercial glazes used to glaze ceramics often contain high concentrations of lead. The ceramic

glazing process produces lead-contaminated dust and should not be done in the home or other environment where children may become exposed to fritted lead glaze or glaze dust. During the firing process, lead fumes may be released and contaminate the air. Ceramics should be fired in a well ventilated area away from children. Since improperly fired ceramic ware can contaminate food, it is often suggested not to use those glazes for food storage containers.

Stained glass making involves the heating of lead solder to join pieces of glass. This produces lead fumes and may contaminate the home if proper ventilation is not used. Additionally, lead filings and scraps may become accessible to children if the work area is accessible to children.

Loading shotgun shells with lead shot can produce lead-contaminated dust. At least one child in North Carolina is believed to have been poisoned by repeatedly sucking on a musket shot. Shooting firearms produces lead fumes and dust. Particularly high lead exposures can occur at indoor firing ranges.

Old pewter contains significant amounts of lead. People who make pewter or melt lead to cast fishing weights or other objects are likely to contaminate their homes with lead fumes.

Food contaminated with lead can be a significant source of lead exposure. Vegetable crops grown in lead-contaminated soil can become contaminated, but this is unlikely to be a source of high dose exposure. Most of the lead contamination in food occurs during processing, particularly if foods are stored in cans with lead-soldered seams. While U.S. producers have ceased the production of lead soldered cans, it is estimated that up to 10 percent of food imported from other countries may be packaged in lead soldered cans. Product recalls have been ordered for some fruit juices and nectars, mandarin oranges, refried beans, jalapeno peppers, and tamales that leached high levels of lead from lead. soldered cans.

Lead in drinking water is another potential source of lead for children. Airborne lead deposited on surface water usually settles quickly into the sediment, so natural sources of water are typically low in lead. Contamination of water supplies with lead generally occurs after the water has left the well or treatment process. Some homes built in the early part of this century contain lead pipes or water tanks. Such plumbing has become rare and does not appear extensively in North Carolina homes. A much more likely source of lead in water is leaching of lead from solder used to join copper pipes. Leaching of lead from plumbing is increased if water is soft or corrosive. Hot water tends to leach more lead than cold water. In recent years some water fountains with lead-lined cooler tanks were found to leach high levels of lead. The water coolers have been recalled by the manufacturers. Lead in water has not been found to be a high dose source of lead exposure to children in North Carolina but it can be eliminated by treating water to reduce its corrosivity.

Much attention has been focused on lead in water because of recent changes in federal guidelines for lead in public water supplies. The maximum permissible level of lead in drinking water was lowered from 50 parts per billion (ppb) to 15 ppb in 1992. Water utility companies are required to test water at the point of use and notify customers if the new lead standard is exceeded. The change in permissible levels of lead in drinking water reflects an improvement in the ability to detect lead at lower levels and is intended to eliminate lead from the nation's drinking water supply.

Lead in traditional medicines used by immigrant cultures can be a significant source of childhood lead exposure, some of those remedies have been brought into this country by recent immigrants. A number of these are from India (bajar, bali guti pills, pushyanug churna). Immigrants from Southeast Asia may use a Chinese remedy (pay-loo-ah) to cure fever and rash. This remedy has poisoned children of Hmong refugees in the U.S. Immigrants from Mexico use lead oxides (azarcon and greta) to treat diarrhea or gastrointestinal upset. Other folk remedies containing lead are alarcon, alkohl, bali goli, coral, ghasard, liga, and rueda.

Cosmetics have historically been a source of acute lead exposure. Strict safety standards in the U.S. have virtually eliminated lead from cosmetics. Lead acetate has been demonstrated as safe in hair dye. Cosmetics from foreign countries may contain lead. A number of cases of acute lead poisoning have occurred in Japan, Britain and the U.S. from use of eye makeup containing up to 80 percent lead sulfide. The cosmetics involved were kohls and surmas from India that are used in some Islamic cultures to darken hair and skin around the eyes.

Earthenware pottery and ceramics are often glazed with materials containing lead. Earthenware pottery, commonly imported from Mexico is not fired at high enough temperatures to stabilize the lead. Craft ceramics produced as a hobby in the U.S. often contain lead that, if not fired properly, can leach into food. Much of the **fine china** imported from Europe and China may leach lead. This is particularly true of china that features brightly colored decorations such as fruit and flowers. **Leaded crystal** can also leach lead into liquids. Many of these items can be safely used for occasional serving of food but may leach dangerous levels of lead into foods or beverages stored in them for long periods of time. This is particularly true for acidic juices and alcohol.

Imported candies (particularly those from Mexico) and the wrappers containing them have recently been identified as important sources of lead exposure.

Lead has been used as an ingredient in many **inks and dyes.** Food manufacturers have been replacing leaded pigments in food wrappers with safer products and alternatives to leaded ink are available and used by many printers. Children may still be exposed to lead by chewing on colored print or from burning paper with leaded ink in wood stoves or fireplaces.

Other household items accessible to children, such as **vinyl miniblinds**, have also been recently recognized as important sources of lead exposure. Of special concern, is the accumulation of lead-contaminated dust on the surface of plastic miniblinds, either from deterioration of the blind or as a result of transfer from nearby lead-contaminated surfaces.

Lead Poisoning Hazards

State law governing the childhood lead poisoning prevention program set forth in G.S. 130A-131.5 - 130A-131.9G defines "lead poisoning hazard" as the presence of readily accessible lead bearing substances, including lead-based paint, measuring 1.0 milligram per square centimeter (mg/cm^2) or greater by x-ray fluorescence or 0.5 percent or greater by chemical analysis; 15 parts per billion (ppb) or greater in drinking water; 40 micrograms per square foot (ug/ft^2) for dust on floors; 250 ug/ft^2 for dust on window sills; 400 parts per million (ppm) or greater in bare soil in play areas, gardens, pet sleeping areas, and areas within three feet of the foundation; and 1,200 ppm or greater in bare soil in other locations. "Readily accessible lead-bearing substance" is defined as any lead poisoning hazard that is capable of being ingested or inhaled by a child less than six years of age. To determine that a lead poisoning hazard exists to children, it must be found to exist in sufficient quantity and it must be readily accessible to a child less than six years of age.

Two methods are used to determine whether or not lead exists in sufficient quantity to present a hazard to children. The XRF analyzer is a portable detector used in the field to determine the quantity of lead on a surface (mg/cm^2). To determine the percent lead content of a substance such as soil, water, or dust, samples must be submitted to a laboratory for analysis. Samples collected during an investigation may be analyzed at the State Laboratory of Public Health where atomic absorption spectroscopy is utilized. In addition to these quantitative analyses, it must be determined that the lead is in an area accessible to young children. The following are examples of lead poisoning hazards frequently identified.

Deteriorated Lead-based Paint

Lead-based paint that is peeling, chipping, cracking, flaking or blistering presents a hazard regardless of location because paint chips or flakes can fall within reach of children. Chalking paint presents a hazard if children have access to the dust generated by chalking paint.

Lead-based Paint and Lead-contaminated Dust on Abrasion Surfaces

Windows with movable sashes generate large amounts of paint dust that collects in window troughs and can contaminate other parts of the house or become accessible to children when windows are open. Thresholds, stair treads and floors are also subject to friction.

Lead-based Paint and Lead-contaminated Dust on Impact Surfaces

Surfaces such as door edges and jambs are subject to repeated impact are likely to generate paint fragments.

Lead-based Paint and Lead-contaminated Dust on Mouthable Surfaces

Lead-based paint on any readily accessible substance or chewable surface on which there is evidence of teeth marks or mouthing is considered a lead poisoning hazard.

Soil Contaminated with Lead-based Paint

Contaminated soil is typically found near the foundation or in the drip line of a house or other structure such as an outbuilding or fence.