The History of Lead-Based Paint

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Overview

Lead-based paint was first made and used in Greek and Roman times. It was the traditional paint of choice and flourished in Renaissance painting and European guild halls. Lead-based paint was shipped in Colonial days to what became the United States as a luxury good, and was later used to paint such important structures as the White House, the Capitol and Mount Vernon.

Master painters – those who typically began as young apprentices in the craft of painting, progressed to becoming journeyman painters before finally attaining the level of a master painter – dominated the demand for paint in the United States. On job sites, they hand mixed white lead in oil with additional oil to make paint, adjusting the mixture to meet specific job site requirements.

Public health expert views of the benefits and risks of using lead paint are the best guide to assessing its acceptance.

Although aware of the potential risk from occupational exposure to lead, master painters preferred to use white lead in oil because they believed that it was superior to non-lead paints. The domination of the paint market by master painters – the era of master painters – continued until World War II.

When lead-based paint was marketed before 1978, it was a legal product in great demand because it was washable and durable. It was repeatedly endorsed by the U.S., state, and local governments and specified for use on government buildings until the mid-1970s.

When white lead pigment was used in paints, currently reported risks to children were unknown and unknowable. That's because the knowledge of the risks of lead evolved over a century.

As that scientific knowledge changed, new pathways for ingestion of lead were discovered and children's blood lead levels that were thought to be safe were lowered dramatically. As knowledge of the risks evolved, so too did the actions of the paint and pigment manufacturers, which history shows cooperated with public health officials and acted responsibly at every turn.

Plaintiffs' expert witnesses acknowledge, and admitted in the California public nuisance trial, that information on the risks of white lead paint was always publicly available and known to public health officials of the day, and the lead pigment and paint manufacturers never conducted secret studies or hid information from the public or public health officials. Accordingly, public health expert views of the benefits and risks of using lead paint are the best guide to assessing its acceptance.

Evolving Knowledge of Risks

The nature and concept of childhood lead poisoning changed profoundly over the years.

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Dr. Jane Lin-Fu, a former Department of Health, Education and Welfare (HEW) public health official, was HEW's leading expert on lead risks to children in the 1960s and 1970s. In a book chapter entitled, "Health Effects of Lead, an Evolving Concept," she wrote in 1985, long before there had been any lead pigment trials:

> *"[I]t should be obvious that what constitutes the health effects of lead is an evolving concept that has changed dramatically since lead toxicity was first recognized in ancient times."*

> *"In the last 10 to 15 years [since 1970-1985], as scientific advances and modern technology have provided more sensitive measures of biochemical, psychological, and electro physiological changes associated with relatively low levels of lead exposure, the concept has undergone further scrutiny and changes that were fraught with controversies."*

Industrial Disease

In the late 1800s and early 1900s, lead poisoning was largely an industrial disease of adults, with stark and easily diagnosable symptoms. For painters, the problem was caused by prolonged exposure to large amounts of paint dust created from sanding and scraping walls previously painted with white lead.

In the late 19th century, Americans began switching from wallpaper to painting the interiors of their homes. The "germ theory of disease" had been developed, and there was a fear that wallpaper and glue had many little nooks and crannies that could harbor germs. Paint could be washed, and lead paint could be washed more vigorously with soap and water than other non-lead paints. The use of lead-based paint on exteriors was widely recommended in order to protect wood from rotting and metal from rusting.

The Rise and Fall of the Use of Lead-Based Paint

When white lead pigment was used to make house paint it was in great demand for use in private homes and public buildings because it was washable and durable.

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Use of white lead peaked in 1922, when the top public health concern was sanitation, specifically in the fight against the worldwide epidemics of Spanish influenza, tuberculosis, and other infectious diseases.

As a War Production Board official wrote in 1944: *"The use of basic carbonate white lead in the paint, varnish and lacquer industry for interior paints is negligible."*

The federal government, as well as California and most state and local governments, specified the use of lead-based paints on buildings into the mid-1970s, decades after the companies voluntarily ceased selling lead pigment for use in interior house paint. But, even before public health officials recommended against any interior lead paint use, white lead had almost entirely been removed from interior paint. As a War Production Board official wrote in 1944:

> *"The use of basic carbonate white lead [B.C.W.L.] in the paint, varnish, and lacquer industry for interior paints is negligible. For all practicable purposes we can say the entire consumption of B.C.W.L., in exterior paints required for maintenance of property," adding, "as a result of these formula changes, the actual B.C.W.L. content of paints is already at an irreducible minimum, and any further reductions in the lead content would only be made at the expense of durability."*

Before 1940 the use of white lead pigment for interiors was on the way out. Paint manufacturers used non-lead pigments, such as lithopone, zinc oxide, and titanium dioxide, in many interior paints mixed at the factory. Sherwin-Williams introduced the first, successful water-based paint for interior use in 1941. It had no lead pigments. Its easy use and clean-up and quick drying with no odor launched the do-it-yourself market. The first interior latex paints, which also did not use lead pigments, came on the market several years later as a result of World War II technology. Exterior latex paints were not available until over a decade later in about 1960.

The U.S. Government Consistently Recommended the Use of Lead-based Paint

The federal government had well-trained, experienced paint chemists offering public recommendations and developing federal specifications for lead paint. These paint chemists were also well-versed in the toxicity of lead. They worked in the National Bureau of Standards, part of the Commerce Department, and recommended the use of white lead paint for government buildings as early as 1917, a recommendation they continued to make through the 1960s. P.H. Hickson and E.F. Walker, National Bureau paint chemists, wrote in 1924:

> *"White lead is the most important of the white pigments. It enters into most light-colored paints. And in addition it is the only white pigments that can be successfully used alone in white linseed oil paints intended for outdoor exposure."*

The Bureau of Standards gave similar advice to the City of New York's Board of Education in 1928:

> *". . .it is noted that you propose to use lead and oil paint for the second and third coats. There is nothing better that can be used for these coats. The specification for the first or primer coat is indefinite. There is no reason why if lead and oil paint is used for second and third coats, that it should not also be used for the priming coat."*

It repeated this advice in 1930 to the Board of Education of Minneapolis, adding:

> *"In our opinion, these white lead or lead-zinc paints when properly made and applied are more durable than ready-mix lithopone paint."*

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Paint chemistry texts of the day agreed, citing the unique chemical reaction of white lead carbonate with linseed oil. The cross-linking bonds, like a basket weave, made the paint film both flexible and durable.

Like the National Bureau of Standards, the U.S. Department of Agriculture's Forest Products Laboratory had well-trained Ph.D. paint chemists who tested paints for decades and were also well aware of the toxicity of lead. It, too, continued to recommend lead-based paint, writing in 1953:

"White lead is still one of the most important pigments in good paint. It is probably the most chemically active pigment and by reacting chemically to neutralize the acid decomposition products of linseed and other drying oils, it enables paint films exposed to the weather to retain their toughness and flexibility for a longer period of time. . . .

"It also makes the paint resistant to absorption of water. Tests indicate the paints made without white lead absorb up to several times as much water as those having a substantial amount of white lead, which tends to make them weather more rapidly."

The standard government advice of the day was a preference for paints with lead pigments over non-lead pigments, especially for use in exterior paints.

The 1950 California Department of Education vocational book on painting, in its section, "Course in Painting and Decorating: Part 1 – Materials, Surface Preparation and Paint Application," also endorsed white lead paint:

"Lead pigments are among the most important pigments used in the manufacture of paint. Some lead pigments are used as metal primers to protect metal surfaces against rust and corrosion. Others are used to tint white paints and enamels. White lead, which is used as the fundamental ingredient in many interior and exterior finishes, is the oldest known white pigment."

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It was not just in paint that the U.S. government recommended the use of lead. In May 1925, U.S. Surgeon General Hugh Cumming appointed a blue ribbon panel of experts and interested parties to consider the pros and cons of a new fuel compound that included tetraethyl lead (TEL) as an additive in order to lessen engine knocking. After a public health study and much deliberation, the panel agreed to lift the ban on the sale of leaded gasoline. Although TEL was known to present a risk to factory workers making it, the panel did not believe that its widespread consumer use would present a public health risk.

Lead was also used, and in many cases is still used today, in plumbing products, building products, ceramics, jewelry, electronics and batteries. Lead has also been found in candies, cosmetics, and ethnic foods and remedies. Each of these uses has been more stringently regulated as science evolved. Today, because of its unique properties, more lead is produced worldwide than ever before.

Recognition of the Pathways for Children to Ingest Lead Evolved

At the end of the 19th century and the beginning of the 20th century, children generally contracted lead poisoning from contaminated foods or contaminated water supplies. Neither interior nor exterior residential lead-based paints were seen as a risk to children. As scientists, public health officials and physicians gained more knowledge, the primary pathways through which children were thought to be exposed to lead evolved in three phases:

Pica: For much of the first half of the 20th century, the disorder of pica – the persistent eating of non-food substances with no nutritional value, such as paint or plaster – was thought to be the primary pathway for ingestion of lead by children. Children with pica were found to chew the paint off of toys, cribs and other painted objects within their reach. Scientists and public health officials recommended that physicians educate parents to monitor their children and stop the behavior.

Chipping and Peeling Paint: Beginning in the mid-1930s, the Baltimore Public Health Department and Johns Hopkins became the first public health officials in the U.S. capable of performing a clinical blood lead test – although it took two days to analyze one sample, and it was nowhere near as precise as today's technology. It was a clinical research tool not suitable for community-wide screenings and was then available in only three laboratories in the U.S.

Baltimore was both the first city in the nation that had the ability to actually test the blood lead level of either children or adults thought to have lead poisoning, and to send a nurse into the home of every lead poisoned child to see their living conditions firsthand.

In 1946, a well-known public health official reported at a conference of the American Medical Association that severe childhood lead poisoning had essentially disappeared. He attributed this development to the end of lead paint use on toys and cribs. The Journal of the American Medical Association (JAMA) continued to report in January 1951 that "the incidence of lead poisoning among children from gnawing on baseboards, furniture or toys is low. At present few coating materials for interiors and furniture contain lead, for economic reasons." Thus, JAMA concluded that the risk of childhood lead poisoning "has been solved on the basis of intelligent understanding and good faith on the part of manufacturers," without federal regulation.

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But in 1948, a different problem emerged, when the Baltimore Public Health Department observed an increase in childhood lead poisoning in Baltimore, primarily among those who lived in its substantial number of rundown, neglected row houses amid massive amounts of peeling and flaking lead paint.

This led health inspectors to investigate those houses and to learn that children were eating lead from peeling and chipping lead paint in that city's inner-city housing, poorly maintained during and after World War II.

As soon as those new concerns were raised, the industry worked closely with public health officials to investigate the risk. The industry provided "no-strings-attached" research funding. That funding helped lead to, in 1951, the Baltimore Public Health Department issuing a ban on the use of lead pigment in interior paint in Baltimore housing. This was the first restriction on the use of interior lead paint in the country.

When the same problem was found in the dilapidated housing in older cities in the Northeast and Midwest, the industry also worked with the American Academy of Pediatrics, along with other groups interested in child health issues, and in 1955 adopted a voluntary national standard to prohibit, in effect, the use of lead pigments in interior residential paints.

When the same problem was found in the dilapidated housing in older cities in the Northeast and Midwest, the industry also worked with the American Academy of Pediatrics, along with other groups interested in child health issues, and in 1955 adopted a voluntary national standard to prohibit, in effect, the use of lead pigments in interior residential paints. This action came 23 years before the federal government banned the use of lead ingredients in residential paint. In the 1950s and 1960s, exterior lead paint was not believed to present a risk to children. Exterior lead paint was not prohibited until the 1970s.

Dust: It was not until 1974 that a new theory emerged on the predominant pathway for children to be exposed to undue levels of lead, in a paper by Dr. James W. Sayre, "House and Hand Dust as a Potential Source of Childhood Lead Exposure." Dr. Sayre felt that the major source might be house dust, contaminated with lead from many sources. The theory was that children were licking their hands that had become dirty with lead-contaminated dust. His theory brought about a move beyond the earlier recognition of a risk from chipping and peeling paint. He also observed that average blood lead levels of children living in low-risk areas of Rochester, New York, were in the range then of 18-25 micrograms per deciliter.

Public Health Recommendations re: Lead Paint

Perhaps the best way to assess what was understood over the years about the potential risks of lead-based paint to children is to look to the views expressed by public health officials who were on the front lines in treating lead exposure and wrote about their findings in widely circulated public journals.

Public health officials recognized that children could be exposed to lead by prolonged chewing of objects with lead-based paint. Thus, in 1931 the U.S. Surgeon General said that lead paint had "wide fields of usefulness" so long as it was not used on babies' cribs and toys. The Children's Bureau, a division of the Department of Labor and later the Department of HEW, gave the same advice. Children's Bureau physicians also warned parents to watch their children to prevent them from chewing on painted objects.

Neither government office ever recommended that lead-based interior paint not be used until concerns arose in the 1950s about peeling and chipping paint. The National Bureau of Standards also issued public educational materials advising against use of lead paint on cribs and toys.

No public health official in the U.S. recommended a stop to using lead-based paint inside homes before 1950.

The Baltimore Public Health Department, often working in conjunction with Johns Hopkins, played a leading role in lead poisoning investigations from the mid-1930s through the mid-1950s. In radio programs the department advised parents to keep children from chewing on painted objects, and to make sure that objects like cribs and toys had no lead paint. That was the mainstream advice of the day, and no public health official in the U.S. recommended a stop to using lead-based paint inside homes before 1950.

Evolving Science Since the End of Lead Paint

Interior lead-based paint was rarely marketed after 1940 and never marketed after 1955.

The change away from interior lead-based paints was facilitated by breakthroughs in paint technology and formulation spearheaded by defendants. They developed, promoted and used non-lead pigments as they became technically and commercially feasible. Exterior lead-based paint use continued, but declined significantly through the 1950s and 1960s, and ended by the early 1970s. Since that time, medical science has continued to evolve, leading to concerns about childhood health that had not existed when lead-based paint was marketed.

When the federal Lead Paint Poisoning Prevention Act was passed in 1971, Dr. Julian Chisolm, a major researcher and treating physician in Baltimore in the field of childhood lead poisoning from the mid-1950s through the end of the century, offered a summary of the state of knowledge about lead poisoning in a scientific paper. He wrote:

"Is it possible that a content of lead in the body that is insufficient to cause obvious symptoms can nevertheless give rise to slowly evolving and long-lasting adverse effects? The question is at present unanswered, but it is most pertinent."

Lead poisoning was diagnosed through visible symptoms up to that time. Dr. Chisolm agreed with the concept that childhood lead poisoning has a threshold when he wrote in 1971:

"Mild symptoms may be found in the presence of values of between 60 and 80 micrograms of lead per 100 milliliters of blood. As the blood lead level rises above 80 micrograms, the risk of severe symptoms increases sharply."

Dr. Chisolm also wrote:

"Childhood lead poisoning in the U.S. is seen almost exclusively in children of preschool age who live in deteriorated housing built before 1940."

In what is sometimes called Chisolm's Triad, Dr. Chisolm characterized the three causative factors for childhood lead poisoning from lead paint:

- Children got lead from paint flakes that had fallen from walls and ceilings from deteriorated, dilapidated old houses.
- Toddlers with pica, and
- Parents with inadequate resources, whether it be emotional, intellectual, informational, or economic inadequacies.

Unacceptable Blood Lead Levels Changed Dramatically

Throughout the medical history of lead, public health officials and lead researchers believed that there was a threshold exposure below which harm did not occur. Prior to 1970, that threshold was generally considered to be 60 micrograms per deciliter or above.

Public health officials did act on Dr. Chisolm's recommendation to set a blood lead standard that provided a margin of safety. In 1971, the U.S. Surgeon General wrote:

> *"Until further studies indicate otherwise, it is recommended that a blood lead concentration of 40 micrograms or more per 100 milliliters of whole blood (as validated by the dithizone technique) determined on two separate occasions be considered evidence suggestive of undue absorption of lead either past or present."*

The concept of "undue absorption" of lead was new, and it resulted from children discovered in community-wide screening tests. Those tests, started in the mid-1960s, demonstrated that many of those children were exposed to sources of environmental lead causing above-average blood lead levels, but they did not have the overt symptoms that had been the major concern of pediatricians up until the 1970s.

Only in the late 1970s did comprehensive epidemiological studies of children's blood lead levels begin . . . This is when modern concerns about low asymptomatic blood lead levels were first raised.

The Surgeon General designated HEW's Bureau of Community and Environmental Management to follow up. It appointed a committee that established a "daily permissible lead intake from all sources for children" of 300 micrograms, a standard which the American Academy of Pediatrics also adopted in 1972. So, as recently as 1972, the government and the Academy considered it safe for children to consume some lead on a daily basis as long as their blood lead levels did not exceed 40 micrograms per deciliter.

Blood lead level testing was not widely available for community-wide screening until the mid-1960s to early 1970s. Before then, a diagnosis of childhood lead poisoning was based on overt symptoms, which typically do not manifest themselves until a child reaches a blood lead level of 70-80. Medical treatment of chelation is not currently recommended until a child has a blood lead level of 45 micrograms per deciliter or above.

Only in the late 1970s did comprehensive epidemiological studies of children's blood lead levels begin, when more sophisticated computer operating systems and newly developed software made such studies possible. This is when modern concerns about low asymptomatic blood lead levels were first raised.

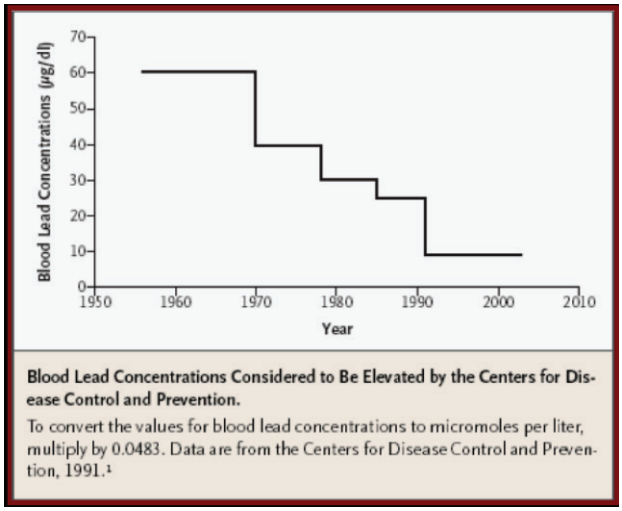
The epidemiology studies first raised concerns in 1979 about blood lead levels of 25 or above; by 1991, the blood lead level of concern dropped to 10 or above. And it was not until 2003 that the alleged risks to children of very low levels of lead in blood below 10 micrograms per deciliter were first reported.

Key Changes in Blood Lead Level Guidelines

The evolving advances in scientific thought – from pica as the primary means of ingestion of lead to chipping and peeling paint, and then to dust – coupled with the new concept of undue lead absorption, federal funding for public health research, computer-assisted epidemiology, community-wide screening and technological breakthroughs in blood lead analysis, led to the dramatic lowering of blood lead levels thought to be safe:

- In the 1930s and 1940s, blood lead levels of 80 micrograms per deciliter or above were thought to be unacceptable.
- Until the late 1960s, public health officials believed that 60 micrograms per deciliter or above was unacceptable.
- In 1972, 40 micrograms or above.
- In 1985, the Centers for Disease Control (CDC) lowered the level to 25 micrograms or above.
- In 1991, acknowledging the change was based on "very recent research," the CDC lowered it again, this time to 10 micrograms or above, where it remained until
- 2012, when the CDC established a different measure of blood lead levels – the "reference" level – which is intended to mark the blood lead level below which 97.5 percent of U.S. children fall; that was set at 5 micrograms.

A CDC graph shows the dramatic reductions from the 1960s through 1991:



Blood Lead Concentrations Considered to Be Elevated by the Centers for Disease Control and Prevention.

To convert the values for blood lead concentrations to micromoles per liter, multiply by 0.0483. Data are from the Centers for Disease Control and Prevention, 1991.[1]

Binder S, Falk H. Strategic plan for the elimination of childhood lead poisoning. Atlanta: Centers for Disease Control, 1991.

By way of example, in the 1970s the average blood lead level for Americans was about 15 micrograms, so by the reasoning of some plaintiffs, 99 percent of Americans then living were lead poisoned. By then, lead from a multitude of sources was ubiquitous in the air, water, soil and food in all industrial societies.

Queensland and Europe

Critics of the former manufacturers of white lead pigments sometimes point to overseas developments that they contend should have provided early alerts to the dangers of lead-based paint. American health authorities were well aware of these foreign developments, but found them to be irrelevant to lead exposure in the U.S.

In 1904, Dr. Lockhart Gibson published a series of reports about lead poisoned children in Queensland, one of Australia's six states. Gibson found that children were eating desiccated white lead in oil while playing for hours every day on large verandas of their houses – porches set on pylons that extend out from homes and that were common to Queensland.

> *"In this semi-tropical climate," he later wrote, "the sun soon converts paint into a powdery substance. The powder rubs off easily on the hands," a powder that was a "very soluble carbonate of lead."*

Gibson himself later freely acknowledged that it "has been difficult for those practicing in other parts of Australia to recognize the special conditions under which our children live, and the special facilities they have for ingesting lead." Dr. Chisolm wrote that,

> *"For 70 years, the epidemic of lead poisoning in Queensland children was not believed by physicians elsewhere who apparently considered the Queensland physicians primitive and perhaps addlepated by the heat."*

Dr. Gibson's findings were not accepted in any of Australia's five other states, much less anywhere else in the world. American doctors noted what was happening in Queensland, but concluded that the circumstances were unique to Queensland and not found in the U.S.

Critics also point to the fact that some European countries adopted bans on interior lead-based paint starting in the 1920s, following a recommendation of the International Labor Organization. These bans were adopted to protect painters from occupational risks, not children from the unrecognized risk of lead paint in their homes. Most industrial nations, including Australia, Germany, the United Kingdom, and the United States, did not ban lead paint then.

The United Kingdom, for example, conducted three extensive studies of lead paint and painter health. It concluded that safe work practices could prevent poisoning and that substitutes for lead paint were inadequate. As in the UK, the U.S. health authorities recommended safe work practices to prevent painter lead poisoning and thus made a ban unnecessary.