Kevin Weinert

Mr. Acre

AP Calculus

4 February 2013

Lead Poisoning Problems

Ever wonder why some students do not perform in school as well as others? Poor student performance may be due to lead in the body. Lead is a toxic metal found in abundance in nature. Its abundance, low cost, and physical properties resulted in the use of lead in many products such as house paint and pipes. However, lead has been banned in house paint since 1978 (HomeSafe) and in pipes since 1986 (Lead in Drinking Water) because of its discovered toxicity. But people today still ingest lead through lead-based paint in older homes, contaminated soil, drinking water from lead pipes, and household dust (Lead). When people, and especially children, have high levels of lead in their bodies it is called lead poisoning and this can lead to adverse effects.

Lead poisoning occurs when lead, which is a neurotoxin, enters a person’s body. Some experts believe that five to nine micrograms can cause lead poisoning to occur. The US Centers for Disease Control and Prevention reports that ten micrograms or more is a level of concern. Children ingest lead more easily than adults by eating chips of peeling paint, putting their hands or toys in their mouth when covered with lead dust, or breathing in lead dust from the air. Lead ingestion is difficult to detect because lead has no taste or smell and does not produce any immediate symptoms. Inside the body, the lead particles then move through the bloodstream to the tissues and organs, which then damages or destroys the cells and leads to many detrimental effects (Lam).

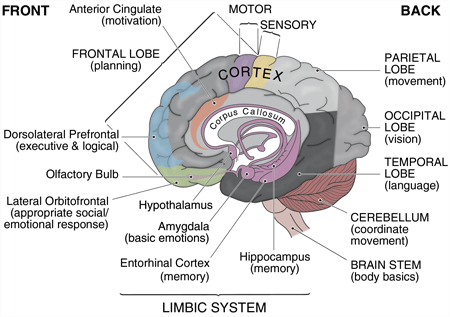
Once lead enters the body it has many detrimental effects. The area with the most detrimental effects is the brain. In the brain, lead causes learning and behavior problems and can cause the intelligence level of children to decrease (Lam).

Figure 1. Diagram of the brain with areas affected by lead highlighted (The Brain – Diagram and Explanation)

Figure 1 shows the parts of the brain and the functions of each part. Lead entering the cerebral cortex (also known as frontal lobe) can cause damage to the frontal lobe inhibiting normal appropriate behavioral development in children. Additionally, when lead enters the hippocampus of the brain it can result in persistent cognitive impairment and memory issues. Also, when lead enters the cerebellum of the brain it can result in impairment of fine motor skills. Lead's effects in these areas of the brain can also impair visual and auditory sensitivity in children. Additionally, high lead levels cause problems similar to attention deficit disorder (Finkelstein). In children, high lead levels can result in a decrease in IQ points, with children losing 7.4 points for the first ten micrograms of lead, and an additional 4.5 points for each additional ten micrograms ingested (Lam). Lead causes the most damage to the brain but can also cause damage to other areas of the body.

The detrimental effects of lead can spread to the bones and other tissues following ingestion. Lead can stay in the bones for decades causing damage because lead destroys cells and tissues. Additionally, lead from the bones can be leaked into the bloodstream and enter organs and tissues causing further damage. For example, in the kidneys, lead does not get filtered out and causes damage to the kidneys (Lam). The detrimental effects that lead has on the brain and body can lead to difficulty learning.

Lead can cause damage to the brain and body and this can lead to difficulty learning. Lead in the brain can decrease the intelligence level of children which makes it hard for them to learn. The lead can also cause behavior problems that will distract students and cause them to have difficulty learning. Finally, lead can cause learning disabilities which directly interfere with a student's ability to learn (Lam). Not only does lead poisoning cause many learning and behavioral issues, but once it enters the body it is hard to get the lead to leave the body.

Once lead is in the body it is difficult to rid the body of lead. Euler's method is used with differential equations to create a regression equation to model growth over time. Duke University developed a hypothetical scenario that created differential equations and can be used with Euler's method. In the hypothetical scenario a constant 49.3 micrograms (µg) of lead was ingested daily, and certain amounts of lead traveled through the blood, tissue, bones, and external environment as waste products daily. This allowed for a modeling situation to determine how lead builds up in the body and how hard it is for the lead to leave the body (Borrelli).

Figure 2. Graph of the hypothetical scenario over 800 days

Figure 2 shows an Excel graph of the amount of lead in the body over 800 days based on the mathematical models created in the hypothetical scenario using Euler's method. It can be seen that the amount of lead in the blood and tissue levels off and does not increase much after about 150 days. However, the amount in the bones continues to increase with no leveling off point observable. Because the amounts of lead level off while a constant amount of lead is added daily shows that lead must leave the blood and tissues while lead is still being added so, the lead could potentially leave the blood and tissue in a lead free environment over time. However, the increase of lead in the bones may imply that lead does not leave the bones or it takes a long time for the lead to leave the bones.

Figure 3. Graph of the hypothetical scenario over 800 days with a lead free environment after 400 days

Figure 3 shows a graph of a different scenario where after 400 days the person was placed in a lead free environment for the remaining 400 days. The graph shows that once the person is placed in the lead free environment after 400 days the amount of lead in the body decreases. Around 800 days the amount of lead in the blood and tissue is close to zero micrograms but not precisely zero. This shows that it is possible for lead to eventually fully leave the blood and tissue but it takes more than 800 days. However, since the lead level is below five micrograms it is a manageable amount of lead in the blood and tissue (Lam). Additionally, shortly after the 400 day mark, the amount of lead in the bones appears to level off and then begins decreasing just below 2500 micrograms of lead. Because the amount of lead started to decrease in the bones it shows that it is possible for lead to eventually leave the bones. However, lead leaves the bones at such a slow rate that it would take until the 590th day for the lead level to stop increasing.

Based on figures 2 and 3 it is possible for lead to leave the body over a long period of time in a lead free environment. Because it is possible for the amount of lead in the body to decrease over time early detection of lead poisoning is essential. If lead poisoning is detected early it may be possible to move those affected to a lead free environment and prevent possible further damage. However, damage that had all ready been caused by lead poisoning cannot be reversed (Lam). Early detection of lead poisoning is essential to preventing further damage and knowing areas where lead poisoning is a serious problem is an essential step to determine risk.

Determining if the community where someone lives has a high concentration of people with lead poisoning can help determine someone's risk of lead poisoning. In Detroit, which is a major metropolitan city, there are high lead levels among many children.

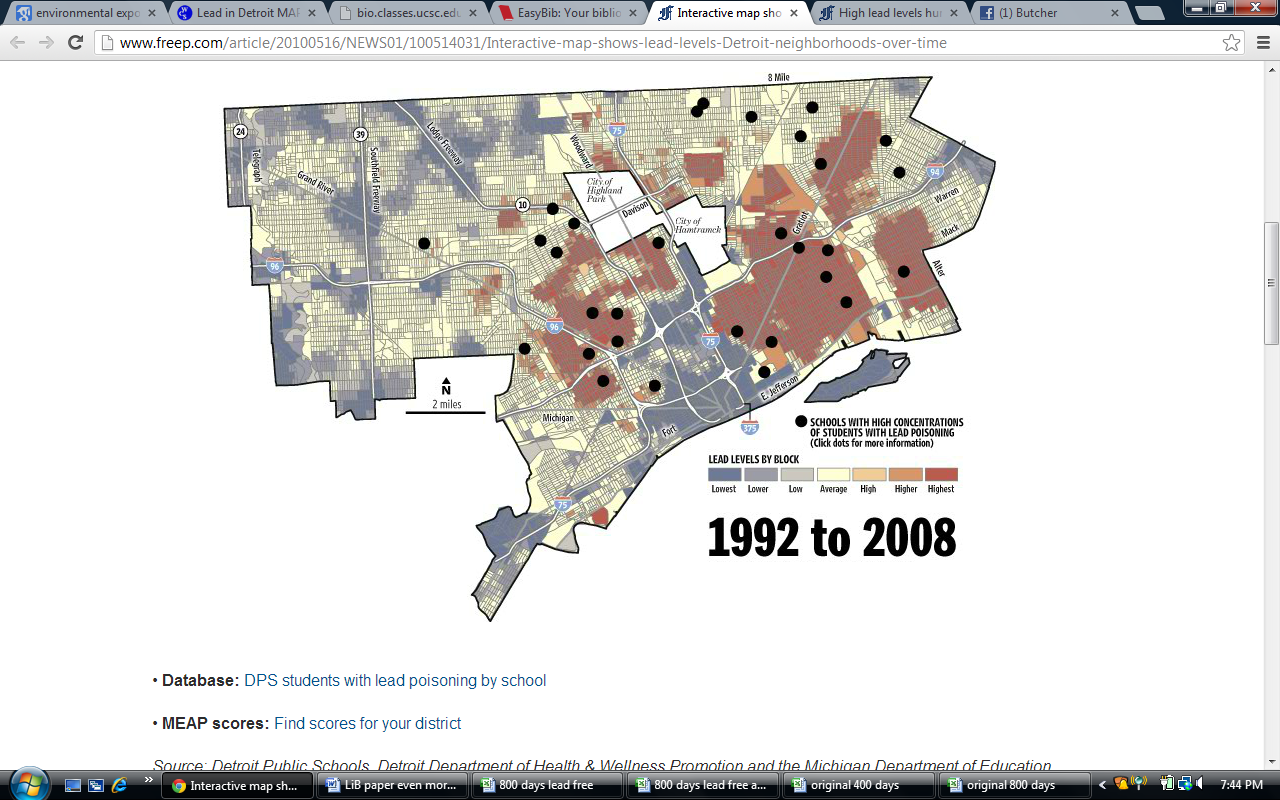


Figure 4. Map of lead levels in Detroit, Michigan (Tanner-White)

Figure 4 shows the lead levels of students in the city of Detroit. It is shown that there are many areas in the city with a high concentration of students with lead poisoning. This is due to older homes and buildings which once contained lead paint and pipes. These high levels of lead poisoning in Detroit are a serious problem for the city and the entire southeastern Michigan community. The high lead levels of children in Detroit contribute to lower test scores and learning problems (Lam). Lower test scores and problems learning can lead to the students quitting school before graduating and that leads to additional problems within the community. Clearly, lead poisoning is a serious problem in the entire community around the city of Detroit.

Lead poisoning is a very serious problem for both children and adults. Lead poisoning in children can cause learning issues and lower intelligence. The damage caused by lead in childhood is irreversible so the effects are carried over to adulthood. Additionally, because it is hard for lead to leave the body lead poisoning can keep causing problems in adulthood. To fight the serious problems caused by lead poisoning the people living in the communities affected by lead must minimize their risk. They can do this by having their homes tested for lead. They can also reduce risk by making sure that they do not have lead pipes in their homes and that any paint in their house is lead free. People, especially those in communities affected by lead poisoning, need to be educated in the causes and effects of lead poisoning. Assistance from the government and community groups in fixing lead dangers in older homes is needed. Schools in high risk areas must be aware of the learning difficulties these students face and provide the educational skills to help with learning. Finally, people should ensure that children's toys are not painted with lead based paint. If people determine that a manufacturer uses lead based paint in toys the people should boycott that manufacturer until they stop using the lead based paint. Everyone must work together to minimize the risks of lead poisoning to provide the opportunity for success for all.

Works Cited

Borrelli, and Coleman. "Differential Equations, A Modeling Approach." Duke University.

John Wiley and Sons Inc., 1996. Web. 1 Feb. 2013. (Adaption)

"The Brain - Diagram and Explanation." *The Brain - Diagram and Explanation*. N.p., n.d.

Web. 01 Feb. 2013. <http://www.brainwaves.com/>.

Finkelstein, Yoram, Morri E. Markowitz, and John F. Rosen. "Low-level Lead-induced

Neurotoxicity in Children: An Update on Central Nervous System Effects." *Brain Research Reviews* 27 (1998): 168-76. Print.

"HomeSafe: Lead Poisoning Facts." *HomeSafe: Lead Poisoning Facts*. N.p., n.d. Web.

03 Feb. 2013. <http://www.leadpro.com/facts.html>.

Lam, Tina, and Kristi Tanner-White. "Detroit Free Press." *Detroit Free Press* 16 May

2010: 8A-9A. *Detroit Free Press*. 16 May 2010. Web. 01 Feb. 2013. <http://www.freep.com/article/20100516/NEWS01/5160413/High-lead-levels-hurt-learning-DPS-kids>.

"Lead." *National Institute of Enviornmental Health Sciences*. US Department of Health

and Human Services, n.d. Web. 31 Jan. 2013. <http://www.niehs.nih.gov/health/topics/agents/lead/>.

"Lead in Drinking Water." *HE-395*. N.p., n.d. Web. 03 Feb. 2013.

<http://www.bae.ncsu.edu/programs/extension/publicat/wqwm/he395.html>.

Tanner-White, Kristi, et al. "Interactive Map Shows Lead Levels in Detroit

Neighborhoods over Time." *Detroit Free Press*. N.p., 16 May 2010. Web. 02 Feb. 2013. <http://www.freep.com/article/20100516/NEWS01/100514031/Interactive-map-shows-lead-levels-Detroit-neighborhoods-over-time>.