Get the Lead Out

Student Material: Reading Assignment

Introduction

Toxic effects from exposure to lead plague many communities. Many children are at high risk due to environmental exposure. Some children have been poisoned by eating chips of paint containing lead. Many children are at a risk from lead-contaminated dust and soil. Tons of lead were deposited in areas with heavy traffic congestion prior to the use of unleaded fuel. This lead is still in the soil, and children are exposed to it when they play in such areas because they inhale the dust when they breathe. Lead from the soil is even more dangerous than lead from paint because children absorb into their bodies about 40% of the lead in things that are eaten, but they absorb about 90% of inhaled lead particles. In children, high lead levels can cause mental deterioration and impair the child's ability to learn.

It is recommended that children be treated for lead poisoning if tests show they have more than 45 μg (micrograms) of lead for each tenth of a liter of blood. This would be about 0.9 mg of lead in the blood of a 60 lb. child. From this it is clear that very small amounts of lead taken into a child's body can harm the child. What further complicates the problem is that only about 1.5% of the lead is removed from the blood each day. This means that without treatment, it will take a long time for a high level of lead in a person's blood to drop to an acceptable level .

1. Suppose a child has 1.0 mg of lead in her blood. Assume this child's body removes 1.5% of the lead in the blood each day. (Use a calculator for the following questions.)

a. Assuming this child is removed from all sources of lead, how much lead is in her body after 1, 2, 3, and 4 days? Use 4 decimal place accuracy.

b. How many days will it take until the amount of lead in this child's blood drops below 0.9 mg?

c. Develop a function $f(t)$ that gives the amount of lead in this child's blood after t days, assuming no additional exposure.

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2. A child with blood levels of 70-100 μg of lead per deciliter of blood needs urgent treatment. For a 60 lb. girl, this would be about 1.4 to 2 mg of lead in the blood. Suppose this girl has 2 mg of lead in her blood and eliminates 1.5% each day. An acceptable amount of lead in her blood would be about 0.4 mg. (Note that 0.4 mg is "acceptable", not "desirable.")

a. How much lead is in her blood after 1, 2, and 3 days, without treatment?

b. Develop a formula for the amount of lead in her blood after t days. Graph this function and determine how long it will take for the amount of lead in her blood to be cut in half, that is, from 2 mg to 1 mg.

c. Determine how long it will take to be cut in half again, from 1 to 0.5 mg.

d. What is the half-life of lead in the blood and what does this mean?

e. How long will it take until the level of lead drops to the acceptable level of 0.4 mg? to a more desirable level of 0.2 mg?

The treatment for lead poisoning is to give drugs that increase the rate of elimination of lead from the blood through the urine. One problem with this treatment is that the drugs also cause the body to eliminate essential metals, such as zinc. Another problem with this treatment is that the chemicals which cause us to eliminate a higher percentage of lead also cause us to absorb more of the lead from our environment. Thus, the patient needs to be removed from the environment which caused the problem.

Much of the lead absorbed into our bodies is stored in places other than the blood. For example, about 95% of the lead in our bodies is stored in our bones. Thus, after treatment for lead poisoning stops, the lead in the bones and tissues can be deposited back into the blood, causing a rebound effect.

3. It is estimated that less than one hundredth of one percent of the lead in our bones is removed each day by the body's natural processes. (What decimal is equivalent to 1%? Then what decimal is equivalent to one hundredth of 1%?)

a. Develop a function that gives the amount of lead remaining in the 60 lb. girl's bones t days after stopping all exposure to lead. Assume she had 40 mg of lead in her bones when $t = 0$, and assume that only the body's natural processes are involved.

b. Determine how many years it would take for the amount of lead in her bones to drop to 20 mg. To 10 mg.

c. Suppose this girl had 20 mg of lead in her bones to start with. How long would it take for the amount to drop to 10 mg?

4. Another environmental poison that is becoming of as much concern as lead and mercury is cadmium. Cadmium is released into the air from the burning of fossil fuels, such as coal. It tends to accumulate in the kidneys and liver. One problem with cadmium is that it is removed from the body very slowly. Each day, between 0.004% and 0.02% of the cadmium in our body is removed.

a. What is the half-life of cadmium in a person's body?

b. You might try to find out whether there are any industries in your region that burn coal, thus releasing cadmium into the air.

Information in this activity was obtained from the **Merck Manual**, Merck & Co., Inc., Whitehouse Station, NJ; from an interview with Howard Meilke in "Lead Poisoning Report", Acumen Technologies, Inc.; and from **Goodman and Gilman's The Pharmacological Basis of Therapeutics**: A.G. Gilman, L. S. Goodman, T.W. Rall, and F. Murad, Macmillan Pub. Co., NY, 1985.