

# Bling ZINGER

## The Lead Content of Jewelry



By *Christen Brownlee*

**C**ould your jewelry make you sick? You have probably never given much thought to how much a 25 cent purchase could change your life. But last summer, a 25 cent purchase may have forever changed the life of 4-year-old Colton Burkhart and his family. While on a routine trip to the local store, Kara Burkhart gave her son a quarter to use in the gumball machine. For his quarter, Colton's prize was a small gold-colored necklace with a medallion ... just a small trinket, but highly valued by any 4-year-old.

Unfortunately, Colton, like many young children, could not resist the urge to put his new prize in his mouth and swallowed the small medallion. Soon after the accidental ingestion, Colton experienced severe stomach pains and flu-like symptoms. After being taken to the hospital, X-rays revealed that the toy was lodged in his digestive tract. Other tests indicated that Colton's blood levels for the element lead were 12–13 times normal levels ... potentially lethal limits for a young child. The pendant was removed, and subsequent analysis revealed that the toy contained upward of 40% lead! The high levels in Colton's blood were due to lead that was leaching out of the 25 cent toy! If doctors had not identified the source of Colton's illness, he could have died.



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The news of this event sparked a national outcry. Independent testing revealed that many of this nation's leading retail stores were selling jewelry with dangerous levels of lead. The federal Consumer Product Safety Commission also got involved in testing and over 150 million pieces of jewelry have since been recalled. You might be surprised to learn that the jewelry you are wearing even as you read this article may pose a health risk. If lead poi-

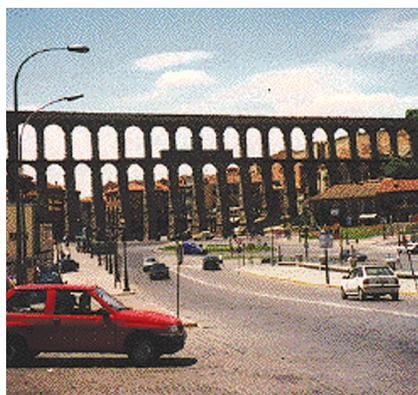
soning is such a serious concern, why would manufacturers use lead in their jewelry and why would retailers carry it? Great question ... glad you asked.

### Lead in history

Lead is used in making jewelry because it is malleable, gives the jewelry some heft, and is inexpensive. The element lead (Pb) derives its name from the Latin *plumbum*, from which

we get our English word plumber, or one who works with lead pipes. It is uncommon to find native lead (elemental form) on the earth but its ores (compounds) are abundant. Lead's primary ore, galena (PbS) can be found in many regions around the world.

Lead is believed to have been the first metal extracted from its ore, most likely the result of heating rock containing galena in a campfire. Lead is a soft metal, easy to work with and able to resist most corrosive environments. These characteristics gave lead great appeal to early humans. As a result, it was widely used in a variety of applications. Artifacts in museums around the world show that lead had appeal to early humans.

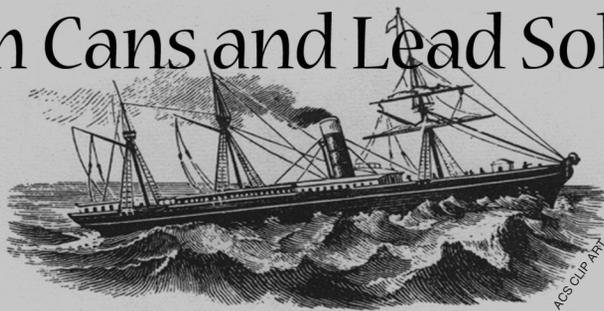


Roman aquaduct in Segovia, Spain (built ~100 A.D.).

Lead use became very common during the Roman era. It is a universally agreed upon belief that the Romans were responsible for promoting the use of lead throughout the known world at the time of the Roman Empire. The Romans, in their attempt to "civilize" their empire, used lead in their plumbing. Lead-lined aqueducts (many of which still stand throughout Europe) brought fresh water to cities; and lead pipes were used to take water to and from Roman homes, public baths, and fountains. Lead was also used throughout the empire as roofing material, wall linings, and other building applications.

Early artisans also found lead to be useful. Lead was used to some extent by jewelry makers, although its dullness made it much less attractive and less widely used than metals such as silver and gold. Early potters enhanced the aesthetic appeal of their creations by adding lead compounds to their glazes. These compounds gave the pottery brilliant color and served a utilitarian purpose as well. These compounds seemed to prevent the pottery from cracking as it cooled after firing. Lead was also added to glass, which sig-

# Tin Cans and Lead Solder



The tin can, invented in England in 1811, could arguably be considered one of the greatest innovations of all time. The ability to can food allowed early explorers to take enough food supplies to last for long periods of time. The practice of stocking ships with canned foods was widely used in the 1800s, an era of exploration. The cans were formed by placing a tin-coated iron sheet around a cylindrical form, overlapping the ends, and then soldering to create a seal. Solder is an alloy of metals that when heated, melts (alloying metals can lower melting points) and flows into the joints where two edges of metal come together. Upon cooling, the solder hardens to produce the seal for the joint. **The solder used at the time was about 90% lead and would not flow easily, making it difficult to obtain a perfect seal.** Poor quality assurance in the can-making process could certainly provide an opportunity for lead contamination.

One such example can be found on Sir John Franklin's tragic expedition to map the Northwest Passage in 1845. The Franklin party embarked on their expedition, never to be seen again. Five years into a search for the crew, three graves were discovered on Beechley Island and on a later search an expedition log was found on King William Island 350 miles to the south. The log reported that the two ships, the *Erebus* and *Terror*, were trapped in ice off King William Island in 1846. The crew had remained with the ships for two years, but Franklin had died in 1847, along with many of the crew. In April 1848, 105 survivors started on a journey across the ice for Hudson Bay to the south. Debris was discovered along what was thought to be the crew's path but that was the only evidence recovered ... the remaining crew disappeared.

In August 1984, Owen Beattie and a team of scientists from the University of Alberta dug up the three graves on Beechley Island ... those of John Torrington, John Hartnell, and William Braine, the first crew members to die on Franklin's expedition. Routine studies carried out on bone fragments of Franklin sailors, as well as those of Inuit Eskimos found in the same area, revealed one striking difference. The lead content of the Eskimo bones was within normal limits, while that of the English sailors examined was 20 times higher. Further analysis on tissue and hair samples confirmed the original findings ... dramatically high levels of lead. On the basis of the evidence, the University of Alberta scientists concluded that the increase in lead content had occurred during the expedition. The crew could have been exposed to a number of sources of the lead, but attention was soon focused on the thousands of tin cans ... enough canned food to last for three years! As strange as it might seem, many of Franklin's crew may have died from complications associated from lead poisoning ... the result of eating food from tin cans soldered with lead solder (3)!



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nificantly improved its clarity. This mixture, known for the "ringing" sound created when lightly struck, is known as leaded crystal.

Lead compounds even found their way into prepared foods. Lead acetate ( $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$ ), known as *sugar of lead*, is water soluble and has a sweet taste. This

compound was sometimes used to sweeten wine and other foods. As we will come to discover, this may not have been one of the Roman's better decisions.

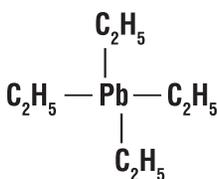
Lead was truly an important metal to early humans. But its value didn't come without a cost. From the earliest times, humankind

has been aware of lead's toxic nature. By the 1st century, the Greek physician Dioscorides noted the relationship between exposure to lead and its toxic manifestations. Noting intestinal problems and swelling as well as paralysis and delirium, he is quoted as saying, "lead makes the mind give way."

## Lead in the modern world

### Tetraethyl lead

Before the 1970s, most gasoline contained an additive known as tetraethyl lead, which decreased the amount of engine "knocking".



As the U.S. population grew during the 1970s and 1980s, so too did gasoline consumption. To keep pace, the manufacture of tetraethyl lead also rose. At one point, approximately 20% of all lead produced in the United States was used as a gasoline additive (1). However, car exhausts released lead directly into the atmosphere making leaded gasoline a major contributor to the amount of lead in the environment. An entire population was being exposed to dangerous levels of lead.

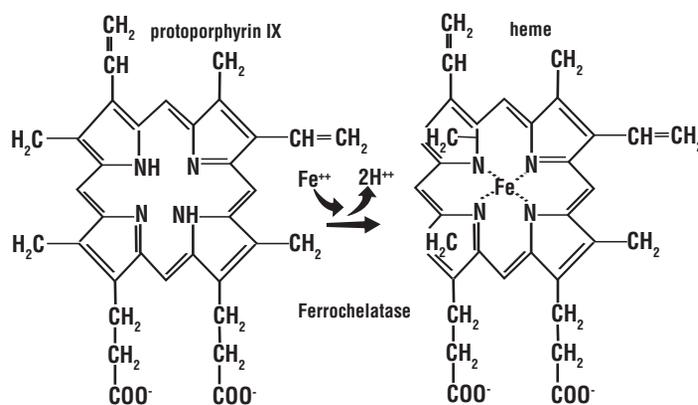
Tetraethyl lead is considered to be a neurotoxin ... a chemical that directly affects the nervous system. When lead enters the body, whether through ingestion, inhalation, or absorption (the three most common routes of entry into the body), it is rapidly absorbed into the bloodstream. From there, it's a quick and costly trip to the brain and central nervous system. Symptoms of exposure are lethargy, tremors, and muscle fatigue. Chronic exposure can even result in brain damage and/or death.



The good news is that times have changed. Data collected over the past 20 years shows a positive trend. Atmospheric lead levels have declined by 90% and not surprisingly, so have the instances of lead exposure. The prohibition of tetraethyl lead as a fuel additive has greatly benefited both the environment and the public's health.

### Lead paint

Lead compounds were also commonly used in the manufacture of house paints. If you were to take a trip to your local hardware store today, you would find it next to impossible to find lead-based paints. But before 1978, lead-based paints lined the shelves! Basic lead carbonate,  $\text{PbCO}_3 \cdot \text{Pb(OH)}_2$ , when pure, is a brilliant white substance that makes an excellent paint pigment, called *white lead*. While the use of white lead has been banned, many buildings still have significant levels of lead-based paints. This has precipitated the U.S. Centers for Disease Control and Prevention to set a "level of concern" for children at  $10 \mu\text{g}$  per deciliter of blood (2). The vast majority of lead absorption in children is through the gastrointestinal tract ... small children tend to put things into their mouths — the gateway to this system! And once an object, such as chip of lead paint, is placed in the mouth, there is a great chance that the object will be swallowed. Let's not forget that lead paint chips do have a sweet taste, which might addition-

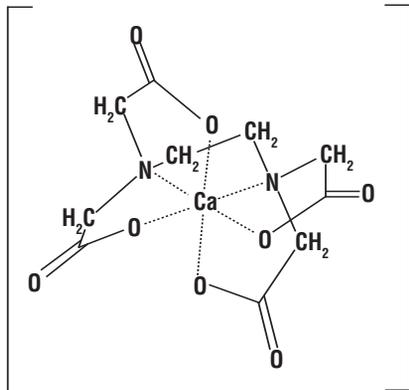


**Ferrochelatase, an enzyme, is responsible for inserting an iron (II) ion into the heme molecule.**

ally encourage a small child to put them into their mouths. This places small children in the high-risk group for lead poisoning. But they are not alone. Anyone who ingests objects with high lead content can absorb significant levels of this toxic heavy metal. Now let us direct our attention to the most recent concern for new cases of lead poisoning ... jewelry.

Lead is a cumulative poison, building up in the body until it reaches toxic levels. Once the body is exposed, lead is quickly distributed to blood, soft tissue (kidney, bone marrow, liver, and brain), and mineralized tissue (bones and teeth). Part of lead's toxicity can be explained by how it interferes with the production of *heme*, needed for red blood cell hemoglobin. An enzyme called *ferrochelatase* is responsible for inserting the iron (II) ion into the heme molecule. Lead ions interfere with this process, and abnormal red blood cells are formed. These abnormal red blood cells are destroyed, but the body may not be able to produce replacement red blood cells quickly enough. Bone marrow attempts to do its part by ramping up production of red blood cells; however, these red blood cells are not sufficiently mature and are likely to be destroyed in the spleen (1). These processes cause the anemia that is associated with lead poisoning, as there is both decreased red cell production and increased red cell destruction. Lead also affects the intestines and vascular smooth muscles. Intestinal spasms due to the contraction of vascular smooth muscle are the cause of some very painful cramps that tend to characterize extreme lead exposures.

Most of lead's neurological effects are due to its ability to mimic and inhibit the actions of calcium ions. Calcium ions play an important role in the nervous system; they help convert the electrical pulse into a chemi-



**Calcium EDTA is used as a chelator in some cases of lead poisoning.**

cal signal. Cells absorb lead ions using the same channels through which they absorb calcium ions. High levels of lead ions are known to cause these channels to uptake more lead ions into the cell, as well as inhibit the transport of calcium ions. Lead ions, even at low concentrations, can both promote and limit the release of the specific neurotransmitters, which are chemicals that regulate the brain. This can have serious consequences on the developing nervous system of an infant or a child. It is believed that this is one of the causes of learning and behavioral problems that occur in children.

In the central nervous system, lead also increases the permeability of the blood–brain barrier, which produces brain edema, an accumulation of fluid in the brain that causes extreme swelling. Lead exposure causes a disruption in this barrier, and the resulting changes in osmotic pressure cause the concentration of water to be altered, and ultimately, edema of the brain and intracranial pressure. With the increased pressure, the neurological development of a maturing child can be altered. As you can see, lead exposure can have severe immediate and long-lasting effects. So what can be done to treat a 4-year-old whose blood contains 12–13 times the normal amount of lead?

## Chelation therapy

A chelator (means “claw-like”) is a chemical substance that acts to bind metal ions and take them out of solution. Designing a chelating agent for treatment of lead exposure can be challenging, because it should not remove essential metal ions (in this instance calcium or iron ions) from the blood, but it should remove the lead ions. Thus, the chelator must have a higher affinity (likes it better)

2- for the lead ions than for the calcium ions. It must also have a higher affinity for the lead ions than the binding sites in the body. Think of this therapy as a microscale *tug-of-war* ... if the chelator can remove the lead ions, the chelator wins; if not, the lead ions remain bound to the cells and the chelator won't work. Also complicating matters is the variety of heavy metal binding sites—with both high and low affinities—within the body. The longer the lead ions are in the body, there is a greater chance that they will migrate from the lower-affinity binding sites to the higher-affinity binding sites. This makes it even more difficult for the chelator to pry it loose. As a result, early chelation therapy is best. Calcium EDTA (Calcium disodium edetate) is the nearly perfect chelator for lead ions. It is water soluble and can be administered intravenously or by injection. Calcium EDTA has a greater affinity for lead ions than for calcium ions; therefore, when lead ions are encountered by the calcium EDTA, the calcium ion “pops” off the chelator and is replaced by the lead ion. When this happens, the lead is not metabolized, is eliminated through the urine, and has few toxic effects.

## Are U.S. teens at risk from toxic jewelry?

So you're a teen, you go to the mall, you see some costume jewelry that you like, and because it's inexpensive, you buy it without giving it much thought. It looks good, you look good, life is good. But a careful inspection reveals that much of this jewelry is manufactured in China, India, Korea, and other countries where labor is cheap, making the jewelry affordable.



The hidden costs might have to be paid for with your health and not with your money! As of July 2004, more than 150 million pieces, found in vending machines and in low-end discount stores nationwide, were recalled. The problem also extends to fine jewelry available at many retail outlets, including malls and jewelry stores. Buyer beware ... your jewelry may be the source of potentially harmful levels of lead.

Currently, there are no federal or state laws that regulate lead content in jewelry. (California may be the exception by publication of this article). Although efforts over the past 20 years have done much to eliminate lead from U.S. food, water, air, etc., the lead content of jewelry seems to have snuck in under the radar! Costume jewelry is cheap enough to attract teen buyers and therefore potentially poses some risk of lead exposure. There is little risk in just wearing this jewelry. The real risk comes when the lead gets into your system. To be safe, be sure you keep your jewelry out of your mouth and out of reach of children, such as younger brothers and sisters.

## A happy ending?

Colton Burkhart, now 5 years old, has undergone extensive chelation therapy to remove the lead from his system. So far, the results have been good, but even a year later, lead levels in his blood remain higher than normal. Only time will tell if his lead exposure will have any long-lasting effects on his development. ▲

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