Could 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.

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 poisoning 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.

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 significantly 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 (Pb(C₂H₃O₂)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 gastrointestinal 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, PbCO₃·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 µg 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 additionally 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.

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

**Chelation therapy**

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.

**References**

2. Department of Health and Human Services, Center for Disease Control (CDC), http://www.cdc.gov/.

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