

# IAOMT's Mercury 101 Online Learning Video Activity Script

International Academy of Oral Medicine and Toxicology (IAOMT); [www.iaomt.org](http://www.iaomt.org)  
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## PREFACE TO IAOMT'S MERCURY 101 ONLINE LEARNING VIDEO ACTIVITY

### *Text on screen:*

Welcome to IAOMT's Mercury 101 Online Learning Video Activity. The "Materials" tab above this video, as well as the text box below this video, contain links to references and resources cited in this activity, scientific literature related to the topics presented, and a script for this entire video. The successful completion of a quiz at the end of this activity is required for individuals participating in an IAOMT course.

In offering this activity, the IAOMT's intention is to present as much scientific information as possible on different dental materials, treatments, patient and dental staff safety, and other aspects of dentistry.

The objective of the Mercury 101 Online Learning Video is that at the conclusion of this activity, participants will be able to recognize the basic properties of mercury and the history of its use in dental amalgam.

The IAOMT emphasizes that health care practitioners must make their own professional judgments for the benefit of themselves and their patients and staffs. You are responsible for exercising your own judgment concerning the specific treatment options to utilize in your practice; for complying with applicable laws and regulations including local dental practice acts and informed consent requirements; and for abiding by insurance requirements including written declarations of coverage.

**Only proceed if you understand and agree with these statements.**

If you are ready to proceed, the activity will begin with William Virtue, DDS, ND, FIAOMT, providing you with the coursework for this Mercury 101 Online Learning Video Activity.

## INTRODUCTION

Dental mercury and dental amalgam safety have been the subject of debate throughout the history of modern dentistry. When the IAOMT was formed in 1984, our first goal was to investigate these very questions.

Over the years we have documented many alarming facts about dental amalgam in the associated mercury exposure. We'll begin by examining a bit of history and some properties of mercury.

## DENTAL MERCURY IN THE 19<sup>TH</sup> CENTURY

Ever since the introduction of mercury silver amalgam as a dental restorative in the early 19th century, dentists have been taught that it is perfectly safe. However, many have wondered how much toxic mercury their patients would be exposed to and if it would present a health hazard.

In the early 19th century, everyone knew that mercury was poisonous. But the mercury silver technique for treating cavities was inexpensive compared to gold, and there did not appear to be any alternative material to combat the onslaught of tooth decay in the general population. The dental organization of the day, the American Society of Dental Surgeons, forbade its members to use mercury, but ultimately economic forces prevailed over health considerations. The Society of Dental Surgeons fell apart in the 1850s due to the controversy over mercury and in 1859 that pro-mercury faction went on to form the American Dental Association that we know today.

### *Screen to the right:*

- Dental mercury has been in use for nearly 200 years.
- Amalgam fillings have saved billions of teeth.
- Its silver appearance has never matched the tooth color.
- Mercury is toxic.
- It is inexpensive compared to gold.
- Mercury fillings were debated even back in the 1850s.
- Economic forces prevailed over health.
- Pro-mercury dentists founded the American Dental Association in 1859.

## ALFRED STOCK AND PAUL BORINSKI

In 1926 after an accidental mercury spill in his laboratory, German chemist Alfred Stock published the first of several papers describing toxic illness that followed exposure to low levels of mercury vapor. He wrote several papers warning that amalgam dental fillings would result in the same type of exposure and coined the term “micromercurialism” to describe the illness.

Stock’s colleague Paul Borinski discovered elevated excretion of mercury and human urine and feces after the placement of mercury fillings using himself as the first subject.

They and others strongly criticized the dentists of the time for using mercury amalgam and documented how some people with amalgam dental fillings displayed the same symptoms as workers exposed to mercury. The controversy raged through the 1930s, but eventually dissipated in the great confusion of World War II. Borinski himself was a Holocaust victim and died in Auschwitz.

### *Screen to the right:*

1926-Chemist Alfred Stock defined “micromercurialism”

1931-Chemist P. Borinsky discovered urine and fecal excretion of mercury

## **DENTAL MERCURY CONCERNS IN THE 1980S**

By the end of World War II, dental amalgam was firmly established as dentistry's principal filling material. The profession downplayed and ignored the mercury content, and the public only knew them as "silver fillings." But in the 1980s, a new generation of investigators armed with instruments better able to detect trace levels of mercury, began again to question the safety of using mercury to fill teeth.

In 1980, Olympio Faissol Pinto, DDS in Brazil, Hal Huggins, DDS in America, and Mats Hanson, PhD in Sweden, revived objections to the use of mercury in dentistry. And in 1984, the IAOMT was founded to document and promote new science on safety of dental materials or techniques.

The controversy they started continues to this day.

## **A DOCUMENTARY ABOUT DENTAL MERCURY**

Before we move on, this video documents the lives of four people as they struggle to inform the federal government, public, and dentists, of the extremely large amounts of mercury vapor and mercury contaminated particulate matter generated during the making, placement, polishing, and removal of mercury amalgam dental fillings.

*Screen to the right:*

*Evidence of Harm* is an hour-long documentary. This short version is the trailer.

## **SCENES FROM EVIDENCE OF HARM**

*Insert Video:*

Trailer from *Evidence of Harm*: <https://youtu.be/JUmiRI42KYg>

## **BASICS ON THE ELEMENT MERCURY**

The controversy surrounding dental amalgam has always centered around the unique properties of metallic mercury. It is the only metal that is liquid at room temperature, and the only one that evaporates, creating a toxic gaseous exposure to people in its vicinity. The vapor is odorless, colorless, and tasteless, but it can easily be detected by analytic instruments.

*Text on Screen:*

Mercury 101:

- Heavy metal
- Atomic number 80 (Gold is 79)
- Atomic weight 200.59
- The only metal liquid at room temperature
- Gas vapor: colorless, odorless, tasteless

- Vaporizes at any temperature over negative 38 degrees Celsius
- Vaporization rate doubles every 10 degrees Celsius
- Very reactive-oxidizes easily

**There are different forms of mercury, and it is essential to understand what they are.**

### **Elemental Mercury, metal form, either liquid or vapor**

Elemental, metallic mercury (used in dental amalgam) vapor atoms have no charge, so are lipophilic, and are able to easily cross biological membranes, including the blood brain barrier.

- 80% uptake in the lungs
- Crosses the BBB (blood brain barrier)
- Moderate uptake in the intestines

### **Inorganic Mercury salt, formed by oxidation of Mercury**

Oxidized, inorganic mercury atoms, with a 2+ charge, cannot cross biological membranes.

- Poor uptake in the intestines
- poor mobility
- does not cross BBB
- causes inflammation in the gut

### **Methyl Mercury**

Methyl mercury is the most common form of organic mercury in the environment, and in the human diet. Levels of methyl mercury had been rising in recent decades in the environment and in seafood, due to the mercury released from burning coal for electrical power. Methyl mercury that we ingest from the diet is easily absorbed in the intestines and is widely distributed throughout the body.

- Formed by bacterial synthesis in the environment, taken up by fish, predominant form in dietary exposure
- Formed by bacteria in our mouth and gut from metallic Hg exposure
- 95% uptake in the intestines, good mobility, crosses BBB, as MeHg-cysteine which causes the methionine transporter

## Ethyl Mercury

Ethyl mercury is a type of organic mercury compound. It is used as an antimicrobial preservative (Thimerosal – sodium ethylmercuric thiosalicylate,  $C_9H_9HgNaO_2S$ ) in some flu shots and vaccines.

- Synthetic form, in thimerosal (EtHg salicylate)
- Used as an antimicrobial preservative in vaccines
- 100% absorbable, crosses BBB rapidly
- Rapidly cleared from the blood as it deposits in body tissues

## MERCURY AND SULFUR

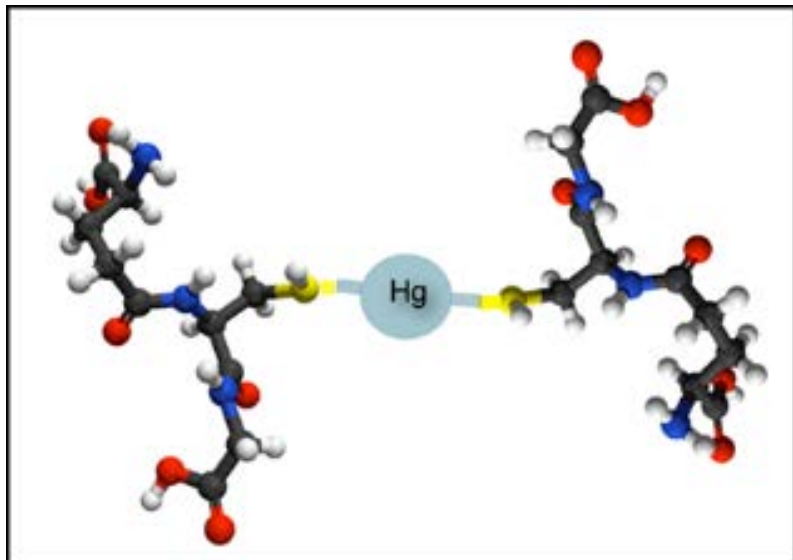
Mercury has two ionic forms: Mercurous and Mercuric. Mercury as a transition metal is capable of covalent bonding, sharing electrons.

Its strong attraction to sulfur is the primary basis of its toxicity. Sulfur containing amino acids and their chemical properties are critical to normal functions of life. At the biochemical level, mercury can inactivate enzymes, disrupt energy metabolism, and break up structural proteins.

By binding with sulfur amino acids, mercury can distort normal proteins, so the immune system mistakenly takes them for antigens. That is the key mechanism that makes mercury such a strong promoter of autoimmune illnesses. Methionine and cysteine are sulfur containing amino acids that are susceptible to binding with mercury. Mercury can also break the S-S bonds in critical proteins.

### *Screen to the right:*

- $Hg^+$  (Mercurous)
- $Hg^{++}$  (Mercuric)
- Tightest covalent bond is with sulfur
- Amino acids are susceptible to bonding with mercury
- Breaks S-S bonds critical to proteins



## ROUTES OF MERCURY EXPOSURE

The toxicity of a given mercury exposure depends on the chemical species involved and the route of exposure. The issue is how effectively the mercury atom can absorb into the body and pass through the cell membranes. Metallic mercury that is ingested is not absorbed to any great degree, although it can be turned into highly observable methyl mercury by the bacteria in the gut.

Metallic mercury vapor is lipophilic and will pass right through the respiratory epithelium. Organic methyl mercury from the diet is extensively absorbed through the digestive tract. Both these lipophilic species of mercury pass right through the lipid bilayer of cell membrane and penetrate deep into the organelles.

***On screen:***

Route	Form	Percent Absorption
Ingested	Metallic Hg <sup>0</sup>	< 0.01 %
Ingested	Inorganic Hg <sup>2+</sup>	< 25 %
Inhaled	Hg <sup>0</sup> vapor	80%
Ingested	Methyl Hg	> 95 %

*Citation: Health Effects Assessment for Mercury, US EPA/540/1-86-042, 1984*

## TOXICOLOGY OF MERCURY

Mercury has been called the most toxic non-radioactive element in nature. Toxicology and toxic risk assessment science have never found a safe level of exposure, no threshold below which mercury is not harmful.

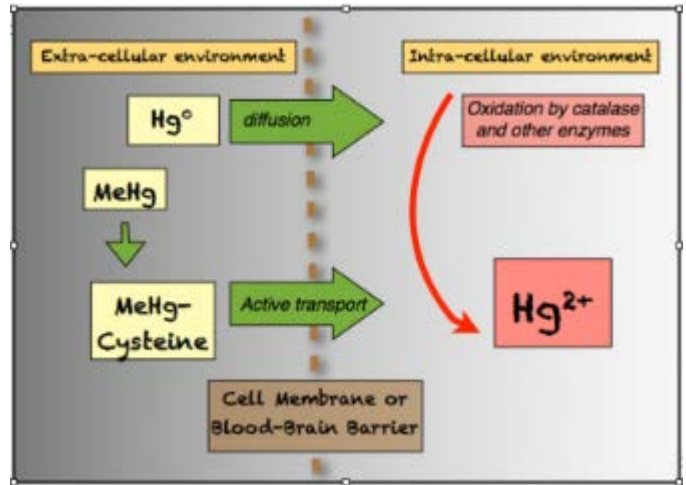
The toxicity of mercury is far reaching inside our cells, in our retention of its toxicity, our overall health, including a daunting array of symptoms and its effects on mothers and children.

**Text on screen:**

**Inside the cell:**

Once inside the cell, both metallic and organic mercury will be oxidized by catalysts and other common enzymes to the inorganic mercuric form, Mercury 2+, the final toxic species.

Inorganic mercury, in the form of charged ions, does not pass through cell membranes, and gets stuck inside the cell. Once that happens, it can be only be eliminated by the active process of cellular excretion.



**Retention toxicity:**

It's impossible to say how long mercury stays in the body after exposure because each tissue responds differently. The half-life of elimination varies from tissue to tissue.

Again, it depends upon the chemical species of mercury, the route of exposure and the time course of exposure. An acute exposure, like a meal of high mercury swordfish, will create an elevated blood mercury level that dissipates within days to weeks.

Acute exposure in blood,  $T_{1/2} = 30$  days

Long-term low-level exposure, like that created by daily occupational exposure, or by the presence of amalgam fillings in the mouth, leads to a slow accumulation of mercury in all tissues of the body, including the kidneys, brain, endocrine glands, and the digestive tract. Mercury is a "bio-accumulative" toxin.

Chronic exposure to brain,  $T_{1/2} = 30$  years

An individual person's susceptibility to mercury toxicity depends on the many complex biochemical factors determining his or her ability to excrete the toxic element. As the tissue levels slowly go up, unpredictable toxic thresholds can be reached, and toxic reactions began to occur. This is what we mean by the concept of retention toxicity.

**Overall health:**

With its strong affinity for sulfur, mercury tends to bind to the sulfur amino acids that form the active sites of enzymes, making those enzymes inactive and non-functional.

This has consequences at the level of overall health. When mercury binds to an enzyme, the enzyme no longer functions.

99% of enzymes have sulfur groups at the active site.

For example, mercury is known to bind to the energy producing enzymes of the electron transport chain inside mitochondria and degrade a cell's ability to produce ATP. This can happen all over the body - affecting the muscles, the nervous system, the oxygen carrying capacity of the blood. This is why one of the best-known symptoms of mercury toxicity is fatigue.

Another prominent group of enzymes inactivated by mercury is the complex responsible for cellular excretion, the phase II conjugation enzymes. The result is that mercury poisons the cell's and the body's ability to excrete mercury. Mercury creates its own retention by inactivating excretory enzymes.

### **Array of symptoms:**

Properly diagnosing "adverse health effects" related to dental mercury amalgam fillings is impeded by the intricate list of potential responses to the elemental form of the substance, which include over 250 specific symptoms. However, some of the symptoms most commonly associated with inhalation of elemental mercury vapors include

- acrodynia,
- anorexia,
- cardiovascular problems,
- cognitive impairments such as memory loss,
- delusions,
- skin problems,
- thyroid disruption,
- emotional instability,
- fatigue,
- headaches,
- hearing loss,
- immune system impairments,
- insomnia,
- decreased motor function,
- oral manifestations,
- psychological issues,
- kidney problems,
- respiratory problems,
- shyness,
- tremors,
- and weight loss.



## **Dental Mercury Amalgam, Pregnancy, & Children**

“Maternal mercury exposure impacts the fetus. Both the Environmental Protection Agency and National Academy of Science state that between 8 and 10% of American women have mercury levels that would render any child they gave birth to at risk for neurological disorders.”

---Haley BE. Mercury toxicity: genetic susceptibility and synergistic effects. *Medical Veritas*. 2005 Nov;2(2):535-42.

Scientific research published in peer-reviewed journals has also shown...

1. The number of maternal amalgam fillings has been associated with mercury levels in cord blood; in the placenta; in the kidneys and liver of fetuses; in fetal hair; and in the brain and kidneys of infants.
2. The mercury concentration in breast milk increases as the number of amalgam fillings in the mother increases.
3. Risk assessments have also explored designating safe levels for children, who are smaller and still developing, especially since many dose levels are based on a one-size-fits-all scale for both children and adults.

### **From the IAOMT Position Paper against Dental Mercury Amalgam Fillings for Medical and Dental Practitioners, Dental Students, Dental Patients, and Policy Makers**

Dental mercury amalgam fillings can potentially exacerbate and/or contribute to the conditions stated below, as well as a myriad of other health outcomes:

- Allergies, especially allergy to mercury
- Alzheimer’s disease
- Amyotrophic lateral sclerosis (Lou Gehrig’s disease)
- Antibiotic resistance
- Autism spectrum disorders
- Autoimmune disorders/immunodeficiency
- Cardiovascular problems
- Chronic fatigue, fatigue, and/or myalgic encephalomyelitis/chronic fatigue syndrome
- Complaints of unclear causation
- Dermatitis
- Fibromyalgia
- Gastrointestinal issues and/or irritable bowel syndrome
- Hearing loss

- Kidney disease
- Micromercurialism
- Multiple sclerosis
- Oral lichenoid reaction and oral lichen planus
- Orofacial granulomatosis
- Parkinson’s disease
- Periodontal disease
- Psychological issues such as depression and anxiety
- Reproductive dysfunction
- Suicidal ideations
- Symptoms of chronic mercury poisoning
- Systemic lupus erythematosus
- Thyroiditis

### **MERCURY AND THE BRAIN**

Mercury has a unique form of toxicity in the brain. It is the only toxin that can disrupt the structural protein of the axon, called tubulin, which then results of all the signature biochemical pathologies of Alzheimer's disease, including the formation of “neurofibrillary tangles.”

This video from the University of Calgary shows the direct effect of mercury causing degeneration of brain neurons.

***Insert Video:***

University of Calgary: How mercury causes brain neuron degeneration:  
<https://youtu.be/pPVxiDpsNDg>

### **CONCLUSION**

Mercury toxicology is a vast subject, and we have just begun to scratch the surface in this brief session. Many more articles and references can be found at the IAOMT website at [www.iaomt.org](http://www.iaomt.org).

### **POSTFACE TO IAOMT’S MERCURY 101 ONLINE LEARNING VIDEO ACTIVITY**

***Text on screen:***

You have finished viewing the video component of this activity. If you are participating in this activity as part of an IAOMT course, you must successfully complete a quiz to obtain credit. Access to the quiz is provided in the “Activity Content” below this video, as well as on the menu to the left. Additionally, the “Materials” tab above this video contains links to references and resources cited in this activity, scientific literature related to the topics presented, and a script for this entire video. Thank you for learning with the IAOMT, as we work together to achieve safer dentistry and a healthier world.