

IAOMT's Mercury 102 Online Learning Video Activity Script

International Academy of Oral Medicine and Toxicology (IAOMT); www.iaomt.org

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PREFACE TO IAOMT'S MERCURY 102 ONLINE LEARNING VIDEO ACTIVITY

Text on screen:

Welcome to IAOMT's Mercury 102 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 102 Online Learning Video is that at the conclusion of this activity, participants will be able to recognize notable scientific research related to dental amalgam mercury.

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 102 Online Learning Video Activity.

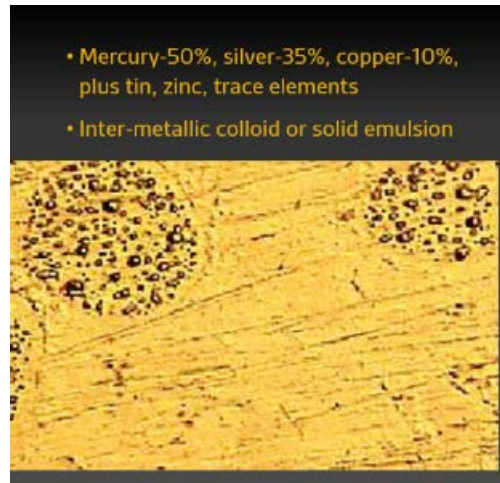
WHAT IS DENTAL AMALGAM?

We have learned a great deal about dental amalgam in recent decades, about how mercury is released from fillings, how the human body absorbs it, transports it, accumulates it, excretes it, and about its toxic impact.

What kind of metal is amalgam anyway? It's certainly not an ionic compound like table salt, or an alloy of metals. It best meets the definition of an inter-metallic colloid, or solid emulsion. The matrix material, in this case of liquid mercury, is not completely reacted, and is recoverable. The fact that amalgam fillings release mercury is no longer in doubt.

This image, for example is a photomicrograph of a polished metallurgical sample of dental amalgam. After its surface is abraded it can be seen to “sweat” microscopic beads of liquid mercury.

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Insert video:

Smoking Teeth=Poison Gas Video: <http://www.youtube.com/watch?v=9ylnQ-T7oiA>

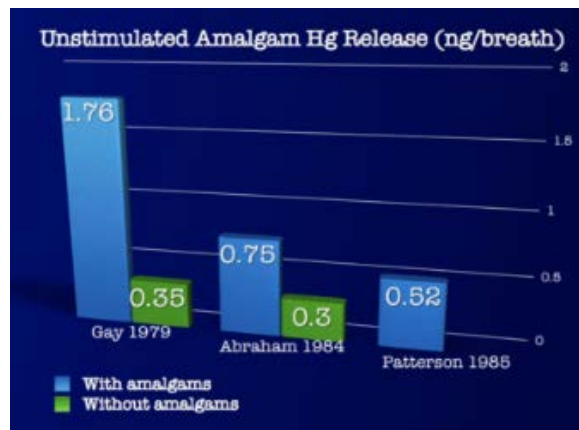
1970S AND 1980S CLASSIC DENTAL LITERATURE ON MERCURY RELEASE FROM DENTAL AMALGAM

The old dental literature is full of references that document release of mercury from amalgams. Three classic papers from the 1970s and 1980s document how much more mercury vapor is found in the mouths of people with amalgam fillings as compared to people with out.

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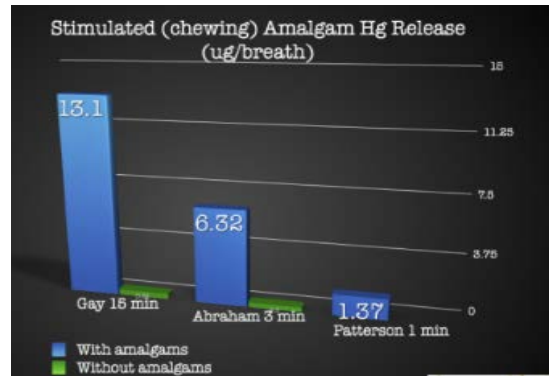
With and Without Amalgams:

The following graph illustrates the results of three classic papers from the 1970s and 1980s that document how much more mercury vapor is found in the mouths of people with amalgam fillings as compared to people without fillings. The small amount of mercury noted in the mouths of people without amalgams reflects the margin of error of the instruments used in that research.



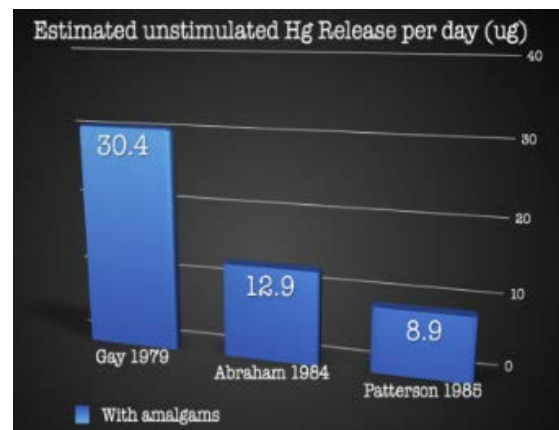
Chewing Gum:

This chart illustrates how the three papers all show that chewing done for a few minutes with amalgam fillings in the mouth raised the level of mercury release by over seven times!



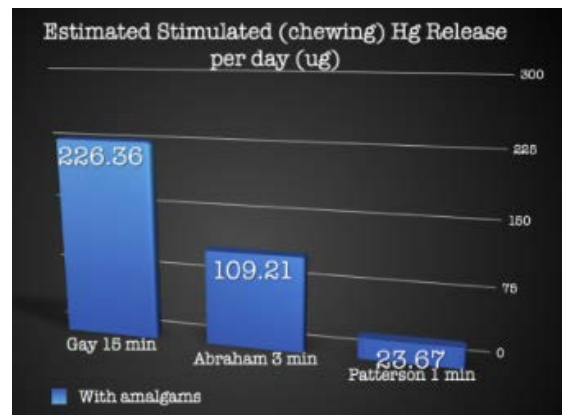
Unstimulated Release:

This chart shows that without any stimulation at all, the mere presence of amalgam fillings in the mouth presents a person with real measurable quantities of mercury exposure, 24 hours a day.



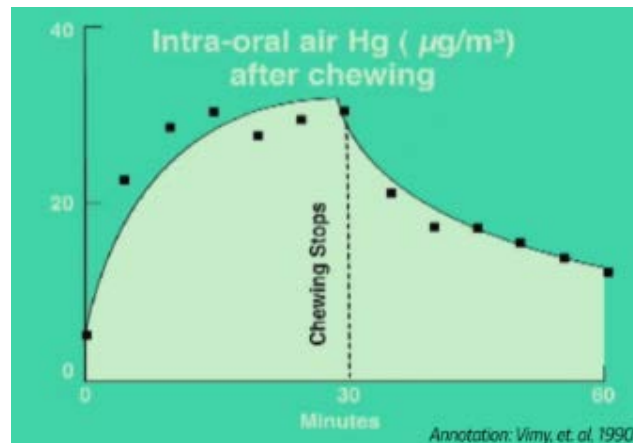
Stimulated Release:

It's no secret that amalgam fillings continuously release elemental mercury vapor into their environment. In fact, it's been in the dental literature since the 19th century. This chart showing estimates of daily amounts of mercury exposure from amalgam fillings with chewing activity reminds us that any form of stimulation that heats an amalgam filling, like the friction of chewing gum or drinking hot drinks, will greatly increase the release of mercury vapor.



Additional Data:

In this experiment, subjects with amalgam fillings had the baseline mercury levels in their mouth air measured, and then they were asked to chew gum for 10 minutes. As expected, the mercury levels in their mouths increased, and those levels took about 2 hours to return to baseline. The fillings continued outgassing long after the simulation stopped.



MORE DENTAL MERCURY RESEARCH IN THE 1980S

Many papers document the release of mercury from dental amalgam under in vitro conditions.

In one such experiment, conducted by IAOMT members, amalgam samples of several different brands were made up. Each with a surface area of one square centimeter, placed in distilled water at room temperature, with no agitation at all. After being left for 90 days to finish their initial set, the water containing the amalgam sample was analyzed daily, for 28 days, using a Nippon Direct Mercury analyzer. The results showed that the amalgams released between 4 and 22 micrograms of mercury into the water per day.

It's not a mystery. It's just a property of mercury dental amalgam.

Screen to the right:

- amalgam samples one square centimeter area
- placed in distilled water at room temperature
- analyzed daily for 28 days
- amalgam samples released 4-22 micrograms Hg per day

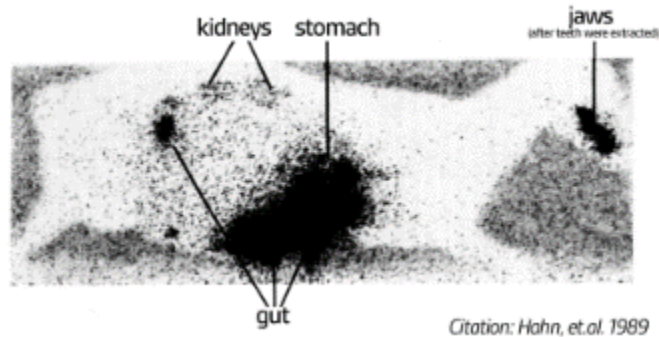
In the late 1980s, a research group at the University of Calgary, in Canada, including IAOMT founder Dr. Murray Vimy, did this experiment to find out if mercury from amalgam fillings could travel through the body. They placed 12 occlusal fillings in the mouth of a pregnant sheep. The amalgam was labeled with Mercury-203, a radioactive isotope that is not found in nature.

After 30 days, the sheep was killed and radioactive mercury was found in all of its organs, plus all the tissues of the fetus.

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The Sheep's Body Scan:

This picture shows the full, body scan of the animal with mercury concentrated in his digestive tract, kidneys, and jawbone.



Mercury Deposit Amounts:

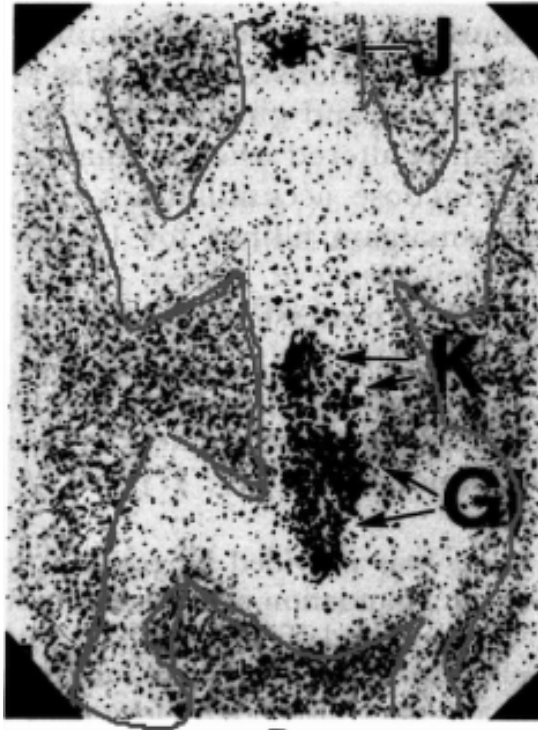
This table shows how much mercury was deposited in some of the sheep's tissues. The kidneys and digestive tract got the most, but the blood and the urine got very little. Blood and urine levels of mercury turn out to be poor indicators of the total body burden of mercury derived from amalgam fillings.

Tissue Concentrations	ng Hg/ gram
kidney	7438
feces	4489
stomach	929
liver	772
alveolar bone	318
whole blood	9.0
urine	4.7

Citation: Hahn et al, 1989

Results Duplicated in a Monkey:

The Calgary group was criticized for using a sheep- an animal that eats and chews in a way very different from humans. So, they repeated their experiment with a monkey, and found identical results. Radioactive mercury from the fillings distributed throughout the animal's body and concentrated in the same organs as the sheep.



MERCURY EXPOSURE LEVELS FROM DENTAL AMALGAM

In 1991, the World Health Organization noted that when mercury amalgam was the predominant dental filling material, people were being exposed to mercury far more by their fillings than from any other source.

Documenting exposure is one thing, but to document toxic exposure, we must compare the exposure to published safety limits.

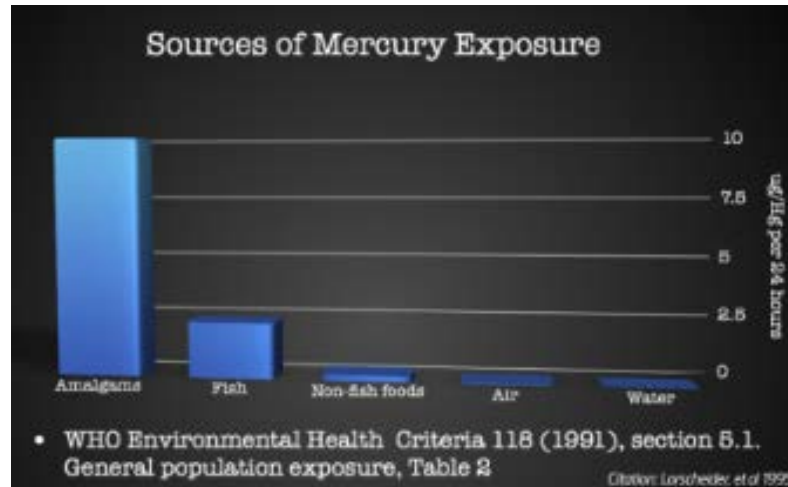
Most published estimates of amalgam-derived mercury exposure show a range exceeding those limits.

Text on screen:

World Health Organization Mercury Amalgam Graph:

In 1991 the World Health Organization published this graph, which shows that when mercury amalgam was the predominant dental filling material, people were being

exposed to mercury far more by their fillings than any other source. This is the picture we can change by eliminating the use of mercury amalgam in the future.



Exposure Exceeds Allowable Limits:

Having mercury fillings in the mouth can expose people to amounts of mercury exceeding occupational exposure limits, and far exceeding limits for indoor air. In the dental office, opening an amalgam capsule or drilling out an old filling can expose dental personnel to far higher levels of mercury than is allowed for occupational settings.

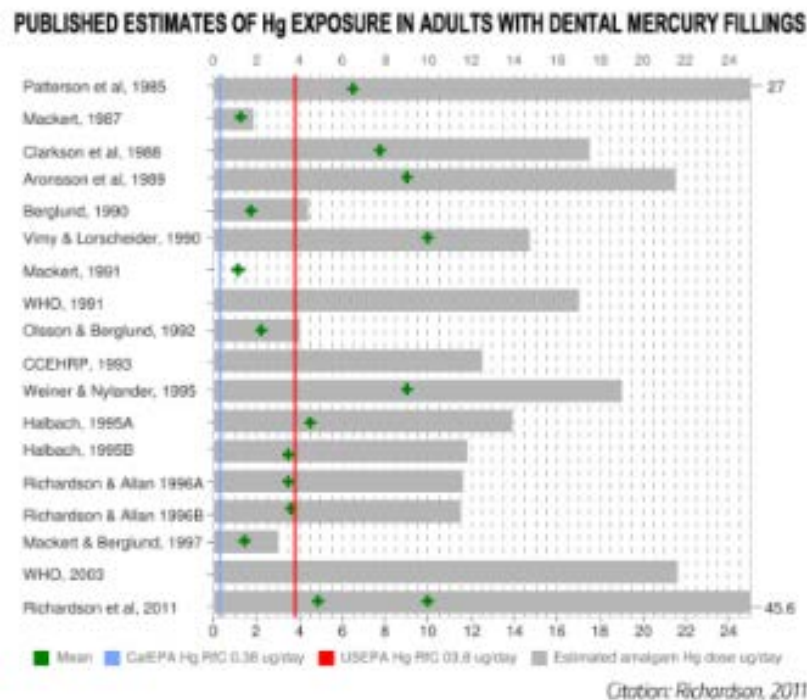
The US Occupational Safety and Health Administration allows 50 micrograms of mercury per cubic meter of air in industrial settings, while the US Environmental Protection Agency allows only 0.3 micrograms per cubic meter for the general public. Exposure to amalgam under various circumstances can create mercury exposures that greatly exceed those limits.

This table shows some mercury measurements taken from the scientific literature for various types of exposure to amalgam and compares them to published safety limits.

Maximum allowable Hg vapor, µg/m ³	6 amalgam fillings, mouth air, 30-120 µg/m ³	Opening a mixed amalgam capsule, 1000 µg/m ³	Dry drilling old amalgam fillings, 4000 µg/m ³
OSHA: 50	2X	20X	80X
EPA: 0.3	400X	3,333X	13,333X

Published Estimates of Mercury Exposure

This graph represents 18 published estimates of the range of daily mercury exposure and adults who have amalgam fillings, as compared with the allowable limits established by various government agencies for non-occupational settings. Each gray bar represents the range of estimated exposure according to that study. The green cross is the mean. The red line represents the daily limit allowed by the US Environmental Protection Agency, and the blue line represents the limit allowed by the California Environmental Protection Agency. As you can see, most published estimates of amalgam derived mercury exposure show a range exceeding those limits.



FDA CLASSIFICATION VERSUS AMALGAM RISK ASSESSMENT

In 2009, the US Food and Drug Administration published its long-awaited final classification for a dental amalgam in concluded that it is safe for everyone, regardless of age, sex, or reproductive status.

While there may be many reasons to criticize their report, one of the most important concerns is the risk calculations. The agency based its risk assessment calculation on the proposition that the average daily dose of mercury that Americans are exposed to from fillings is just under the EPA safety limit. But that ignores the 67 million American citizens with more than an average number of fillings, who would be getting more mercury than the EPA limit allows.

No mention at all was made of the possibility that the most people are also exposed to other toxins, especially methyl mercury and lead. This can lead to a condition of synergistic toxicity, where the additional toxic materials multiply each other's effects.

Bullet points to the right:

- FDA approves amalgam fillings for everyone
- 67 million Americans exceed the EPA limit for mercury exposure
- Concurrent exposure- 1/3 of the US population is exposed to methyl mercury and lead, along with amalgams

For more information, see-- Richardson GM, Wilson R, Allard D, Purtill C, Douma S, Gravière, J. Mercury exposure and risks from dental amalgam in the US population, post-2000. *Science of the Total Environment*. 2011; 409(20): 4257-4268.

GLOBAL PHASE DOWN ON DENTAL MERCURY

Government agencies around the world have taken steps to restrict amalgam use due to its effect on health and its environmental burden as a source of mercury pollution. A 1996 report for Health Canada, based on industrial safety limits, concluded that a reasonable exposure limit for an adult would be reached with 8 surfaces of amalgam, and less for children. Meanwhile, amalgam is banned in several countries, and more countries are planning limits on its use.

Bullet points to the right:

- The United Nations Environment Programme (UNEP)'s Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury.
- The treaty aims to phase out and phase down mercury use in a number of products and processes and includes a phase down on dental amalgam.
- It has been ratified by over 100 nations, including the United States.
- The Minamata Convention entered into force on 16 August 2017.
- As a result of the treaty, a growing number of countries around the world are banning the use of dental amalgam.

DENTAL MERCURY AND EFFECTS ON CHILDREN

Many studies have demonstrated effects of amalgam mercury on fertility, maternal and infant health. Infants and young children are known to be more susceptible to the toxic effects of mercury on brain and nervous system development.

Bullet points to the right:

- The fetus, infant, and young children are more susceptible to mercury toxicity than adults.
- A mother's amalgams expose the fetus to mercury from the moment of conception.
- Amalgam mercury passes through the placenta and through breast milk.

Why do dentists think that mercury amalgam is safe for use on people's teeth question, and why do so many dental organizations cling so hard to the old notion of amalgam safety? In an age when there are so many other ways to restore teeth, isn't it obvious that amalgam is no longer necessary, that we can let it go?

The dental literature is in large part responsible. Of the vast literature on mercury toxicity and amalgam toxicity, only a bare minimum is published in dental journals. The great majority of the data is in medical journals, toxicology, physiology, an environmental medicine journals, where it is effectively hidden from the average dentist and the public at large. Even most of the literature on mercury exposure from amalgam lies outside the dental journals.

According to toxicology professor J. Mutter, most studies claiming mercury safety in dentistry show substantial methodological flaws, or simply disregard the basic principles of toxicological research on metallic mercury.

THE CHILDREN'S AMALGAM TRIALS

The "Children's Amalgam Trials" were published in the Journal of the American Medical Association in 2006 and extensively publicized throughout the dental world. These two studies are held to be the final proof that mercury amalgams are safe.

In the DeRouen study, 507 children, age 8 to 10 years, living in the Castle Pia orphanage in Lisbon, Portugal, were divided into a group that had cavities filled with amalgam, and another group that would get composite fillings.

The Bellinger study used the same protocol for 534 children and community health clinics in Boston, Massachusetts, and Farmington, Maine.

Screen to the right:

DeRouen TA, Martin MD, Leroux BG, Townes BD, Woods JS, Leitão J, Castro-Caldas A, Luis H, Bernardo M, Rosenbaum G, Martins IP. Neurobehavioral effects of dental amalgam in children: a randomized clinical trial. *JAMA*. 2006 Apr 19;295(15):1784-92.

Bellinger DC, Trachtenberg F, Barregard L, Tavares M, Cernichiari E, Daniel D, McKinlay S. Neuropsychological and renal effects of dental amalgam in children: a randomized clinical trial. *JAMA*. 2006 Apr 19;295(15):1775-83.

After 8 years of follow-up, the amalgam and composite groups were compared. Both studies reported no difference in IQ and kidney function between them.

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Erroneous Conclusion: Amalgam is perfectly safe for use in children.

CRITICS OF THE CHILDREN'S AMALGAM TRIALS

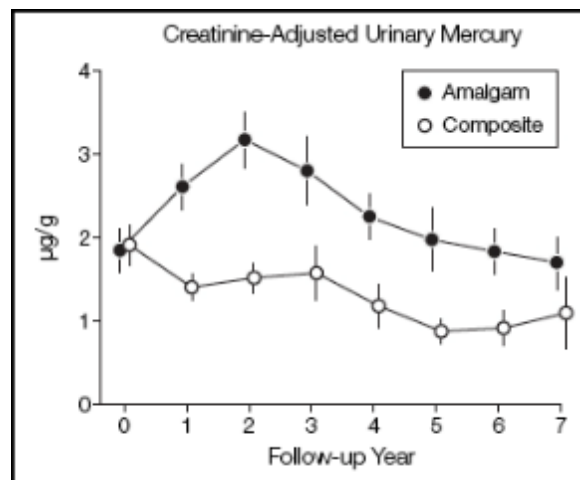
Critics pointed out that there has never been a suggestion in the toxicology literature that mercury exposure would affect IQ, and that the 8-year period of these studies would be insufficient to reveal long term effects of mercury exposure that may take decades to develop.

But the first tangible sign that the argument in support of amalgam safety is faulty was this graph from the original DeRouen paper. It shows a decline in urinary mercury excretion in the amalgam group over the 8-year period. Since amalgam fillings continue to emit mercury, and the children continued to get new fillings as time went on, why would they, especially the boys, excrete less mercury in later years?

This effect was never explained by the authors, but it clearly reflects one of the best-known toxic effects of mercury on the kidneys: inhibition approximal tubule function. This means that mercury exposure poisons the body's ability to excrete mercury.

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Point by point these studies had been refuted



Decreasing mercury excretion despite continued exposure

To their credit, the CAT investigators collected exceedingly detailed records for each of their subjects. The data contained information on exactly which teeth had what kind and what size of filling, in which year, for each specific child. A group led by David A. Geier, sponsored in part by IAOMT, was able to take those data and calculate an actual dose-exposure to either amalgam or composite for each individual child. Their much more specific dose-effect measurements reveal a different story than the original publications, which just lumped all the kids in the amalgam group or the composite group together.

In this paper, data on urinary and porphyrins, a biomarker of mercury toxicity, were part of the original collection of physiological data. Porphyrin markers were compared to actual exposure

to amalgam fillings and were found to be correlated to amalgam exposure in a dose dependent fashion.

Screen to the right:

Geier DA, Carmody T, Kern JK, King PG, Geier MR. A significant relationship between mercury exposure from dental amalgams and urinary porphyrins: a further assessment of the Casa Pia children's dental amalgam trial. *Biometals*. 2011 Apr 1;24(2):215-24.

The actual dose-exposure data for the kids in the Portugal study also showed that their urinary mercury did, in fact, rise with exposure to amalgam. This was in contrast to the conclusion of the original study.

Screen to the right:

Geier DA, Carmody T, Kern JK, King PG, Geier MR. A dose-dependent relationship between mercury exposure from dental amalgams and urinary mercury levels: a further assessment of the Casa Pia Children's Dental Amalgam Trial. *Human & Experimental Toxicology*. 2012 Jan;31(1):11-7.

A third paper by the Geier group showed that, as might have been suspected, the effects of increased amalgam mercury exposure took a toll on the children's kidneys. There was a dose dependent increase and urinary levels of GST-a, a biomarker for kidney stress.

Screen to the right:

Geier DA, Carmody T, Kern JK, King PG, Geier MR. A significant dose-dependent relationship between mercury exposure from dental amalgams and kidney integrity biomarkers: a further assessment of the Casa Pia children's dental amalgam trial. *Human & Experimental Toxicology*. 2013 Apr;32(4):434-40.

"CPOX-4" is a relatively common variant of a gene which codes for an enzyme in the porphyrin synthesis pathway. In this paper by one of the original CAT authors, boys with that variant gene are shown to be more susceptible to the effects of amalgam mercury exposure on their nervous system.

Several other genes are known to increase a person's susceptibility to mercury toxicity. One is the Apolipoprotein E4, which has long been associated with an increased risk of early onset Alzheimer's disease, and has a clear connection to the neurotoxic effects of mercury.

Screen to the right:

Woods JS, Heyer NJ, Echeverria D, Russo JE, Martin MD, Bernardo MF, Luis HS, Vaz L, Farin FM. Modification of neurobehavioral effects of mercury by a genetic polymorphism of coproporphyrinogen oxidase in children. *Neurotoxicology and Teratology*. 2012 Sep 1;34(5):513-21.

Finally, another paper by some of the original authors of the CAT studies show that another common gene variant plays a role in the neurological effects of mercury exposure on children.

In this case, it is the gene for metallothionein, an important protein that affects how cells protect themselves from toxic metals. The study states that there is an increase susceptibility to the adverse neurobehavioral effects of Hg among children with relatively common genetic variants of metallothionein.

It's another demonstration of how some individuals are more susceptible to the toxicity of mercury than others.

Screen to the right:

Woods JS, Heyer NJ, Russo JE, Martin MD, Pillai PB, Farin FM. Modification of neurobehavioral effects of mercury by genetic polymorphisms of metallothionein in children. *Neurotoxicology and Teratology*. 2013 Sep 1;39:36-44.

In the end, the CAT studies only proved what we already knew about dental amalgam: that they provide significant exposure to mercury, and cause significant, measurable, physiological harm. We should notice, too, that all the follow-up papers that refute the original conclusions of the CAT studies were published in toxicology journals, and not dental journals. And there has been no mention at all about these follow-up papers in the dental press.

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Point by point, data from the CAT studies ended up showing

- Significant mercury exposure
- Significant physiological harm

CONCLUSION

In the 21st century, we can finally closeout the mercury era in dentistry for new applications. Happily, we have made much less hazardous materials to use now, as composites, which are vastly less hazardous than mercury, have become the accepted standard for restorative dentistry. But we also have a toxic legacy to account for. Even if all dentist stopped placing amalgam fillings today, we will have to continue to remove and replace old amalgam fillings future. Many more articles and references can be found at the IAOMT website, www.iaomt.org.

POSTFACE TO IAOMT'S MERCURY 102 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.