INTRODUCTION TO UNIT 6

☐ Take the Unit 6 Pre-test
  Click here to go to pages 3-4.

☐ Read “Dental Mercury, the Environment, and Sweden’s Success Story” by Kennedy and Just. Click here to go to pages 5-8.

REQUIRED (MANDATORY) CONTENT OF UNIT 6

☐ Read “Selections from the Minamata Convention” by the United Nations Environment Programme. Click here to go to pages 9-14.

☐ Read the “Dental Amalgam and the Environment” article by Warwick with Just. Click here to go to pages 15-39.

☐ Read “The Minamata Convention on Mercury: Attempting to Address the Global Controversy of Dental Amalgam Use and Mercury Waste Disposal” article by Mackey, Contreras, and Liang. Click here to go to pages 40-44.

☐ View the IAOMT online learning module “Environmental Impact of Dental Mercury” at https://iaomt.org/online-learning/environment/. Click here to go to page 45.

☐ Read the “Fact Sheet: Effluent Limitations Guidelines and Standards for Dental Offices” from the United States Environmental Protection Agency about new guidelines from the EPA. The guidelines were released in December 2016 and went into effect in July 2017. Click here to go to pages 46-47.

Continued on next page…
TEST FOR UNIT 6

☐ Take the Post-Test for Unit 6 at https://www.cvent.com/d/6vq54n. Click here to go to page 48.

☐ If you are interested in learning more about any of the topics in this unit, explore the readings in the OPTIONAL Unit 6 PDF file. Note that these are not required materials.

☐ Continue on to Unit 7! Click here to go to https://iaomt.org/accreditation-materials/.
PRE-TEST FOR UNIT 6 TO BE TAKEN BEFORE STUDYING DENTAL AMALGAM AND THE ENVIRONMENT

*This is a pre-test, and the results are for your records only. You are not expected to know the answers since you have not studied this material yet. The pre-test is simply designed to assist you in recognizing some of the important information that will be presented in this unit. There is no time limit for this test. Choose the option that BEST answers each question.*

1. If the developing population of the world only required one additional amalgam per person, the amount of mercury required to meet this demand would be __________ tons of mercury.
   A. less than 2
   B. approximately 20
   C. approximately 200
   D. over 2000

2. __________ are two of the few industries where mercury usage has been on the rise within the past decade.
   A. dentistry and small-scale gold mining
   B. coal mining and cosmetics
   C. dentistry and coal mining
   D. dentistry and cosmetics

3. Mercury particles from dental amalgam can be taken into __________.
   A. the bare skin of any individual within the sub-micron plume
   B. the protective layers covering the patient
   C. the dental equipment
   D. the hair, clothing, and shoes of the patient and workers
   E. all of the above

4. Environmental pollution from dental amalgam has been identified in research as stemming from amalgams in human due to __________.
   A. urine and feces
   B. cremation and burial
   C. cell phone use close to the jaw
   D. A & B
   E. all of the above
5. Close to __________ of Americans think that mercury pollution poses a serious threat to the environment.
   A. 5%
   B. 28%
   C. 47%
   D. 86%

Mercury’s Damage to the Environment

Although human health risks related to mercury are of major concern, another main reason mercury regulations are being drafted and enforced is because mercury harms the environment. Mercury released into the air, soil, or water has devastating impacts on the ecosystem, including “land-degradation and river siltation and the associated deforestation, loss of organic soil, modification of hydrologic regimes and loss of aquatic habitat.”\(^1\) The pollution can also create “mercury hotspots that last for centuries.”\(^2\)

The toxicity of fish from methylmercury, which is a form of the element transformed by certain bacteria, has resulted in advisories for pregnant women and children not to eat certain types of seafood.\(^3\)\(^4\)\(^5\)

Dental Mercury and the Environment

It is well-known that the use of amalgam in dentistry causes mercury to be released to the environment. Consider for example that the United States Environmental Protection Agency (EPA) estimates dentistry accounts for 14% of the U.S. domestic usage of mercury annually.\(^6\) Also consider that approximately 40 tons of mercury are used each year to manufacture amalgam fillings.\(^7\)

Research has shown that the primary source of mercury in municipal wastewater effluents generally originates from dental practices.\(^8\) In fact, according to the EPA, dental offices were found to have been the source of 50% of all mercury pollution entering publically-owned treatment works in 2003.\(^9\)

Amalgam separators can successfully reduce the amount of mercury discharge in wastewater from dental offices\(^10\)\(^11\) and are essential in stopping mercury from entering the environment. However, it would be helpful to enforce maintenance requirements for amalgam separators, as the Royal College of Dental Surgeons has done in Ontario, Canada.\(^12\) It should also be remembered that amalgam separators only contribute to solving the problem of dental mercury in wastewater and not the additional burdens placed by amalgam fillings on the environment and human health.

Other burdens to the environment caused by amalgam include mercury released in human waste from patients with these fillings,\(^13\) improper disposal of amalgam at dental offices,\(^14\)\(^15\) mercury vapors given off of the fillings,\(^16\)\(^17\) and air discharges from central vacuum systems.\(^18\)\(^19\)

Additionally, dental offices contribute to atmospheric releases of mercury from vapors given off during the cremation of individuals with amalgam fillings.\(^20\)\(^21\)\(^22\)\(^23\)
this as a major source of air pollution is becoming more and more publicly accepted, a fact which is validated by lawsuits.\textsuperscript{24} \textsuperscript{25} \textsuperscript{26} \textsuperscript{27}

For these reasons and more, a variety of environmental agencies have taken measures against dental mercury. The United Nations Environment Programme recently passed a worldwide mercury treaty, which includes working to phase-down dental mercury,\textsuperscript{28} and in the United States, many state environmental agencies, such as the Connecticut Department of Environmental Protection, have worked to educate dentists\textsuperscript{29} and consumers\textsuperscript{30} about pollution caused by amalgam and health risks from mercury.

The Example of Sweden

Sweden was one of the first countries to identify mercury as a persistent environmental biological toxin, and this initiated their evolution into one of the first mercury-free countries in the world. Some have mistakenly described Sweden’s approach to the mercury issue as recycling. Rather, according to the Nordic Council of Ministers, the Swedish government does not suggest recycling but does endorse appropriately handling mercury waste: “The Swedish government has proclaimed, that mercury should not be recycled and that mercury waste should be treated in a way, that makes it possible to store mercury appropriately in the long time perspective. The Swedish EPA recommends a deep mountain depot as the environmentally most safe disposal solution.”\textsuperscript{31}

The Swedish EPA also trained dogs to sniff out residual mercury from abandoned buildings such as manufacturing plants and schools.\textsuperscript{32} With the dogs’ help, they identified hot spots and recovered and stored even more of this highly toxic metal. This dramatically cleaned up their country from the legacy of uncontrolled manufacturing.

Overall, there were very few difficulties in transitioning away from the mercury materials, and the oral health of Swedes did not collapse as the dire predictions had envisioned. Actually, the dental schools stopped teaching the use of mercury, and Sweden quickly became a healthier country for its environment, its citizens, and its future.

If other countries learn from the example of Sweden, the entire planet could benefit from a new level of health. However, since the world appears to have opted to gradually phase-down the use of dental mercury, this means that as a dental professional, you can wait to take action until you are told to do so, or you can protect the environment, your patients, and yourself immediately by not using amalgam in your practice. The Environmental Committee of the IAOMT has pioneered the safe and environmentally conscious dental practice and has encouraged and facilitated all members in bringing their practices into alignment with stringent protections for employees, the environment, as well as patients.

\textsuperscript{1} Pirrone, Nicola; Mason, Robert. \textit{Mercury Fate and Transport in the Global Atmosphere: Emissions, Measurements, and Models.} (New York, 2009).

http://books.google.com/books?id=mnMVfbQQeRMChdp=PA166&dq=asgm+ecosystems&source=bl&ots=IIZNKjc7r8&sig=AFNxt-Xe-c_VXeQUjL_XbEE3E&hl=en&e=--


5 United States Food and Drug Administration. *What You Need to Know about Mercury in Fish and Shellfish*, 2009. [http://www.fda.gov/Food/ResourcesForYou/Consumers/ucm110591.htm](http://www.fda.gov/Food/ResourcesForYou/Consumers/ucm110591.htm)

6 Ibid.


14 Ibid.


Selections from the

MINAMATA CONVENTION ON MERCURY

TEXT AND ANNEXES

This booklet is published for information only. It does not substitute the original authentic texts of the Minamata Convention on Mercury as deposited with the Secretary-General of the United Nations acting as the Depositary of the Convention

www.mercuryconvention.org

October 2013

http://www.mercuryconvention.org/Convention/tabid/3426/Default.aspx for the full text of the convention in six languages
INTRODUCTION

In 2001, the Governing Council of the United Nations Environment Programme (UNEP) invited the Executive Director of UNEP to undertake a global assessment of mercury and its compounds, including information on the chemistry and health effects, sources, long-range transport, and prevention and control technologies relating to mercury. In 2003, the Governing Council considered this assessment and found that there was sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment from the release of mercury and its compounds to the environment. Governments were urged to adopt goals for the reduction of mercury emissions and releases and UNEP initiated technical assistance and capacity building activities to meet these goals.

Mercury is recognized as a substance producing significant adverse neurological and other health effects, with particular concerns expressed about its harmful effects on unborn children and infants. The global transport of mercury in the environment was a key reason for taking the decision that global action to address the problem of mercury pollution was required. A mercury programme to address these concerns was thus established and was further strengthened by governments in decisions of the Governing Council in 2005 and in 2007. In the decision of 2007, the Governing Council concluded that the options of enhanced voluntary measures and new or existing international legal instruments would be reviewed and assessed in order to make progress in addressing the mercury issue.

In 2009, following extensive consideration of the issue, the Governing Council agreed that voluntary actions to date had not been sufficient to address the concerns on mercury, and decided on the need for further action on mercury, including the preparation of a global legally binding instrument. An intergovernmental negotiating committee to prepare a global legally binding instrument on mercury was therefore established, to commence its work in 2010 and conclude negotiations prior to the twenty-seventh session of the Governing Council in 2013. The committee

1 As of February 2013, the designation of the Governing Council of UNEP has been changed to the United Nations Environment Assembly.
was provided with a detailed mandate setting out specific issues to be covered in the text of the instrument, as well as a number of other elements to be taken into account while negotiating the text.

In January 2013, the intergovernmental negotiating committee concluded its fifth session by agreeing on the text of the Minamata Convention on Mercury. The text was adopted by the Conference of Plenipotentiaries on 10 October 2013 in Japan and was opened for signature thereafter. The objective of the Convention is to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds and it sets out a range of measures to meet that objective. These include measures to control the supply and trade of mercury, including setting limitations on certain specific sources of mercury such as primary mining, and to control mercury-added products and manufacturing processes in which mercury or mercury compounds are used, as well as artisanal and small scale gold mining. The text of the Convention includes separate articles on emissions and releases of mercury, with controls directed at reducing levels of mercury while allowing flexibility to accommodate national development plans. In addition, it contains measures on the environmentally sound interim storage of mercury and on mercury wastes, as well as contaminated sites. Provision is made in the text for financial and technical support to developing countries and countries with economies in transition, and a financial mechanism for the provision of adequate, predictable and timely financial resources is defined.

Governments are invited and encouraged to sign the Convention at the offices of the Depositary, United Nations Headquarters, New York, during the period that it is open for signature (until 9 October 2014). Governments are also encouraged to work towards the implementation of the Convention and becoming a party thereto in order to lead to its rapid entry into force.

It is anticipated that coordinated implementation of the obligations of the Convention will lead to an overall reduction in mercury levels in the environment over time, thus meeting the objective of the Convention to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.
MINAMATA CONVENTION ON MERCURY

The Parties to this Convention,

Recognizing that mercury is a chemical of global concern owing to its long-range atmospheric transport, its persistence in the environment once anthropogenically introduced, its ability to bioaccumulate in ecosystems and its significant negative effects on human health and the environment,

Recalling decision 25/5 of 20 February 2009 of the Governing Council of the United Nations Environment Programme to initiate international action to manage mercury in an efficient, effective and coherent manner,

Recalling paragraph 221 of the outcome document of the United Nations Conference on Sustainable Development “The future we want”, which called for a successful outcome of the negotiations on a global legally binding instrument on mercury to address the risks to human health and the environment,

Recalling the United Nations Conference on Sustainable Development’s reaffirmation of the principles of the Rio Declaration on Environment and Development, including, inter alia, common but differentiated responsibilities, and acknowledging States’ respective circumstances and capabilities and the need for global action,

Aware of the health concerns, especially in developing countries, resulting from exposure to mercury of vulnerable populations, especially women, children, and, through them, future generations,

Noting the particular vulnerabilities of Arctic ecosystems and indigenous communities because of the biomagnification of mercury and contamination of traditional foods, and concerned about indigenous communities more generally with respect to the effects of mercury,

Recognizing the substantial lessons of Minamata Disease, in particular the serious health and environmental effects resulting from the mercury pollution, and the need to ensure proper management of mercury and the prevention of such events in the future,

Stressing the importance of financial, technical, technological, and capacity-building support, particularly for developing countries, and
countries with economies in transition, in order to strengthen national
capabilities for the management of mercury and to promote the effective
implementation of the Convention,

Recognizing also the activities of the World Health Organization in the
protection of human health related to mercury and the roles of relevant
multilateral environmental agreements, especially the Basel Convention
on the Control of Transboundary Movements of Hazardous Wastes and
Their Disposal and the Rotterdam Convention on the Prior Informed
Consent Procedure for Certain Hazardous Chemicals and Pesticides in
International Trade,

Recognizing that this Convention and other international agreements
in the field of the environment and trade are mutually supportive,

Emphasizing that nothing in this Convention is intended to affect the
rights and obligations of any Party deriving from any existing international
agreement,

Understanding that the above recital is not intended to create a
hierarchy between this Convention and other international instruments,

Noting that nothing in this Convention prevents a Party from taking
additional domestic measures consistent with the provisions of this
Convention in an effort to protect human health and the environment
from exposure to mercury in accordance with that Party’s other obligations
under applicable international law,

Have agreed as follows:

Article 1

Objective

The objective of this Convention is to protect the human health and
the environment from anthropogenic emissions and releases of mercury
and mercury compounds.
Dental amalgam | Measures to be taken by a Party to phase down the use of dental amalgam shall take into account the Party’s domestic circumstances and relevant international guidance and shall include two or more of the measures from the following list:

(i) Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration;

(ii) Setting national objectives aiming at minimizing its use;

(iii) Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;

(iv) Promoting research and development of quality mercury-free materials for dental restoration;

(v) Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices;

(vi) Discouraging insurance policies and programmes that favour dental amalgam use over mercury-free dental restoration;

(vii) Encouraging insurance policies and programmes that favour the use of quality alternatives to dental amalgam for dental restoration;

(viii) Restricting the use of dental amalgam to its encapsulated form;

(ix) Promoting the use of best environmental practices in dental facilities to reduce releases of mercury and mercury compounds to water and land.
Dental Amalgam and the Environment
By David Warwick, DDS, IAOMT, IABDM, ADAC, IAO, CDA,
with Amanda Just
May 2014
[Adapted from Alert: Mercury Releases to the Environment Caused by Dental Amalgam Fillings, A Report to Health Canada by David Warwick with Amanda Just, April 16, 2012]

An Examination of Three Different Global Dental Profiles

It is universally appreciated that the dental needs of the world are constantly changing. Currently, there are three distinct populations on the planet, who, because of their unique dental situations, each have a profound effect on the global use of amalgam. Understanding these three profiles is essential to assess future needs for dental restoration, as well as quantifying the impact the use of dental mercury has on the world’s environment.

1) Global Profile #1: Populations in Developed Countries

20% of the over 7 billion people on this planet are considered to live in developed countries, and it has been reported that this group has the highest need for tooth restorations. Because residents of developed countries visit the dentist more often, many mercury fillings are already in the mouths of citizens who live in areas with adequate and available medical care. It should be recognized that these are the same people who could need additional medical care due to health issues caused by mercury.

Additionally, according to the United States Environmental Protection Agency (EPA), there is currently over 1,000 tons of mercury in the mouths of Americans, which is more than half of all the mercury being used in the U.S. today. Thus, patients who have amalgam fillings carry a “societal load” of mercury in their mouths.

A significant trend is that the demand for mercury fillings in this “developed countries” group is decreasing slightly, and the amount of mercury being removed from this group is slightly higher than that which is being placed.

2) Global Profile #2: Populations in Underdeveloped Countries

Another 20% of the over 7 billion people on this planet are considered to live in underdeveloped countries. There is difficulty in tracking the need for restorations and dental decay in the underdeveloped population of the world because of a lack of data. Yet, possibly due to a lesser access to fermentable sugars, the reportable decay rate for this group is very low. However, an accurate, statistically-demonstrated need for restorations in underdeveloped countries does not exist until the country moves into a “developing” status.
3) Global Profile #3: Populations in Developing Countries

The population of the developing nations, which comprises the remaining 60% of the over 7 billion global population,\(^6\) presently has a decayed, missing, and filled (DMF) tooth status in 12-year olds more than 2.5 times higher than other populations.\(^7\)

As populations in developing countries gain more wealth, they also have greater access to sugar, and as this consumption increases, the probability is that this population’s DMF will likewise rise.

Regardless of the cause, if the developing population required just one additional amalgam filling per person, the amount of mercury required to meet this demand would be over 2000 tons of mercury \([.5 \text{ gm/filling} \times 60\% \text{ (the developing population)} \times 7.2 \text{ billion (the world population)} = 2,160,000,000 \text{ gm or } 2160 \text{ tons.}]\) This would be added to the current 350 tons that is presently used globally on an annual basis. There is therefore, a profound greater risk of increased planetary exposure to mercury by the use of dental amalgam in countries that are developing.

Furthermore, the pattern of decay in developed countries has followed a very distinct pattern over the last 40 years, which is very relevant for developing countries to take into account.

Previous reports show that as countries were developing, decay rates in the general population rose to a peak of four to eight DMF (in the 1960’s) and then showed a dramatic decrease (today’s levels), as the following chart shows:

![Tooth Decay Trends: Fluoridated vs. Unfluoridated Countries](chart)

It has been hypothesized that increased access to preventative services and more awareness of the detrimental effects of sugar are responsible for the visible decrease of tooth decay in the chart above. However, it should be noted that this trend occurred with and without the systemic
application of fluoridated water, so it would appear that factors other than fluoride caused this change.

In Denmark and Sweden, the decrease in DMF shown in the chart above was concurrent with a decrease in the use of mercury for dentistry. In these two countries, the peak use of amalgam occurred in the mid 1970’s, but it continued to decline simultaneously with the growing practice of using alternatives to mercury.

This is significant because newly developing countries may experience a similar pattern in which decay, and therefore restoration requirements increase substantially before leveling out to developed country levels. In fact, there is evidence of this happening in the world right now. Currently, Latin America has DMF scores over ten in 35-44 year olds. If this trend continues, the use of amalgam would then cause a proportional increase in the risk of mercury exposure to our environment.

The potential increase in dental mercury use is especially concerning in developing countries because these countries usually do not have the resources, infrastructure, or capital to activate proper best practice management (BPM) or to adequately protect the environment, patient, and dental professionals from the mercury in dental amalgam.

Another significant implication in the pattern of developed nations using more dental mercury for fillings is that previously, this trend occurred when environmental issues of amalgam were not known or being considered. Today, we know better, and aside from the easily retrieved mercury waste collected for recycling, the majority of mercury used in dentistry is released to the environment.

**Dispersive Model of Anthropogenic Release of Mercury from Dental Amalgam**

Because the U.S. has some of the most available and up-to-date research on dental health, and because most developed countries have shown similar patterns in dental restoration use, we can conservatively extrapolate the known U.S. data and apply it to other developed nations by multiplying the data by four. (This figure is based on developed populations accounting for 20% of the population and the fact that the U.S. population accounts for one-fifth to one-quarter of the developed countries’ population).

Evaluation of the accessible data shows that dental amalgam creates one of the most dispersive sources of mercury exposure to the environment. Dental use of mercury has globally increased from an estimated 270 tons to 350 tons per year over an eight-year period, which means that dentistry and small-scale gold mining are two of the few industries where mercury usage is on the rise.

One way to assess the environmental impact of dental amalgam fillings is to employ a basic accounting principle for determining the fate of the mercury-containing tooth restorations. Applying estimates of global and domestic mercury usage, using a routine process of accounting, and analyzing available literature, allows one to determine the annual global impact of amalgam on the various subsets of the environment (air, water, soil, and living creatures).
This system helps to identify inadequacies in the use of dental mercury, which assists in gauging BPM (best practice management) in need of improvement in developed countries. This is particularly valuable for countries that are underdeveloped or developing, where decay rates and dental restorations could just beginning to increase.\textsuperscript{11}

Thoughtful consideration must be made as to infrastructure and BPM, which are required to justify the continued use of amalgam in an environmentally responsible and conscientious manner. Developing countries, if they choose to use dental amalgam, will require consultation and capital to build BPM, while avoiding the same mistakes environmental mercury exposure has caused to developed countries over the past 140 years.

As such, below is a flowchart developed by the Government of Denmark on the dispersion of mercury from dental amalgam.\textsuperscript{12} This chart is especially enlightening when remembering the fact that mercury is vaporized from dental amalgam:
The chart above represents a “year’s snapshot” from 2001, and it would be reasonable to extrapolate these numbers to most developed countries using amalgam fillings, as this model was constructed before Denmark rejected the use of amalgam. However, the ratios of dispersion cannot necessarily be extrapolated to all countries since one must take into account the three distinct global population categories of populations outlined above.

In order to fully account for all of possible global dispersions of mercury from dental amalgam, the Danish model can be expanded, as in the chart below, which clarifies other integral areas of consideration:
The Issue of Dental Mercury that Does Not Reach Dental Facilities

Manufacturing Accidents and Small-scale Mining

The annual global use of mercury for dentistry is approximately 350 tons/year.\textsuperscript{13} Considering there is some pre-installation spillage at the manufacturing level, and some of this material is diverted for other uses such as small-scale mining, the actual amount used for dentistry is difficult to confirm.

Because there are no accurate tracking methods on a global scale for the ultimate use of mercury or for amalgam manufacturing spillage of mercury, this becomes the first inadequacy in the management of the material. This statistical issue further identifies the need for a global initiative to design a better BPM tracking model.

Although the percentage of spillage is quite likely much less than 1\%, it is still significant, as it is a notable source of occupational mercury vapor exposure for those who work in amalgam manufacturing.

It is also understood that virtually all of the dental mercury diverted for small-scale gold mining (SSGM) ends up in the atmosphere as a result of burning gold amalgam or in the rivers that are associated with the mining. During 2005 in Brazil, most of the mercury used in SSGM was labeled for use in dentistry,\textsuperscript{14} and the most recent estimates have global anthropogenic release of mercury into the air by SSGM at 1400 tons annually.\textsuperscript{15}

Environmental Dispersion of Mercury after It Reaches Dental Facilities

Mercury from dental restorations enters the environment after it reaches the dental office in two ways: dental mercury is released to the environment from amalgam waste (i.e. amalgam that is not placed in patients’ teeth) and dental mercury is released to the environment from amalgam that is placed in patients’ teeth.

Placing mercury fillings, cleaning them, and/or removing them results in dangerous levels of exposure, as the table below shows:

<table>
<thead>
<tr>
<th>OSHA maximum allowable level of mercury in the workplace during a single exposure</th>
<th>Measurements Taken at a Dental Office Using a Jerome Mercury Vapor Analyzer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing with a triturator</td>
<td>400-600 micrograms</td>
</tr>
<tr>
<td>Opening autoclave with mercury-contaminated instruments</td>
<td>10-50 micrograms</td>
</tr>
<tr>
<td>Opening trap on the back of a dental chair filled with amalgam scrap</td>
<td>300-600 micrograms</td>
</tr>
<tr>
<td>Removing amalgam with water</td>
<td>100-200 micrograms</td>
</tr>
<tr>
<td>Removing amalgam with drill if water is accidentally turned off</td>
<td>1200-2500 micrograms</td>
</tr>
</tbody>
</table>
1) Dental mercury released into the environment from amalgam waste (i.e. amalgam that is not placed in patients’ teeth).

Knowledge of the basic dental process of placing an amalgam filling is necessary to explain the various components of mercury-containing waste created by this routine procedure. Much of this is outlined in the following chart created by Environment Canada; however, there are breaches in the accountability of the mercury’s fate because of a lack of monitoring that likewise need to be addressed.
a) Mercury waste from capsules
The first form of mercury waste created by dental amalgam placement is from the capsules (both used and unused) that contain or have contained the mercury and base metal elements. Each capsule contains 400 to 1200 mg of mercury, and there are plastic containers used to mix in the mercury and base metal components of amalgam.

Although some countries only allow encapsulated dental amalgam, there are still countries that allow the use and importation of bulk mercury for dental purposes. It is difficult to calculate the actual number of mercury-filled capsules that must be stored indefinitely, yet there have been no initiatives until the last decade to control where these capsules end up.

Currently, there is also no international body overseeing the safe disposal of this toxic waste, and as a result, many of the mercury capsules end up in landfills. These unused capsules pose a greater risk to the environment than used capsules because the mercury content in an unused capsule is of greater quantity than the mercury remnants in a used capsule. Therefore, unused capsules have the potential to leak out more mercury over a longer period of time.

The Environment Canada flow chart above suggests that the empty capsules may be thrown in the garbage, as local bylaws allow. This practice means that the incineration of the amalgam waste can result in the production of mercury vapor from the remnants of mercury on the capsules, which would add up to a significant amount when considering the number of amalgam fillings placed in Canada each year.

The only environmentally-safe fate the used or unused capsules have is in indefinite, long-term storage, but interestingly enough, this type of facility has not been developed nationally or globally. In Canada, where only encapsulated dental amalgam is allowed for importation, the approximately 5000 kg of mercury brought in for dental use would yield close to 10 million capsules that require safe disposal annually.

Proactive jurisdictions such as the State of New York have laws in place that require all amalgam capsules to be recycled.16

b) Mercury waste from sundries
The second form of mercury waste from placing an amalgam filling is tainted sundries. Rubber dams, gowns, bibs, barriers, masks, gloves, cotton rolls, suction tips, suction screens, and wipes all have the potential to carry amalgam particles. There are no programs in place to collect and store this waste, and as a result, most of it is either sent to the landfill and/or incinerated as waste or bio-hazardous waste, which obviously emits notable amounts of toxic mercury vapor to the environment.

Additionally, a thorough cleaning of amalgam debris is required for reusable instruments, such as mirrors, pluggers, carriers, rubber dam clamps and frames, carvers, and burs. Generally, this waste is rinsed down the drain. For any instrument that is not properly rinsed, subsequent sterilization can produce occupationally hazardous mercury vapor.17 This second category of mercury waste may account for up to 1 % of the total mercury used for dentistry or 3.5 tons annually on a global basis.
Unfortunately, because the mercury is associated with sundries, the opportunity for recycling this mercury is unlikely. Again, the only other option for BPM for this waste is indefinite storage facilities or separation and recapture of the mercury by using technology such as spiral kilns. Without these types of facilities, the waste will continue to be dispensed into the land fill or down the sewers where it is leached into the environment.

c) Mercury waste from large-sized amalgam particles

The third form of waste from placing mercury fillings is large “chunks” of amalgam measuring more than 1 mm³. These are either unused particles or the amalgam scrapings that are produced when the filling is carved into its final shape. The chunks are supposed to be collected by hand and forceps, screens on suction lines, and amalgam traps.

Then, the amalgam particles are supposed to put in a sealed container and eventually taken for long-term storage/recycling. There are no tracking instruments or long-term storage facilities in place in Canada or anywhere else in the world to ensure this safe practice occurs.

Furthermore, the recommended cleaning of the contents in “amalgam traps” provides another opportunity of vaporization and occupational exposure. This waste is not commonly caught in the “amalgam separators,” but rather the 1mm screens that fit inline on the suction hoses.

Theoretically, the “large chunk” waste of the process would account for most of the unused portion of the mercury in the installation of dental amalgam, or 54% of the amalgam not placed into patients’ teeth. This adds up 175 tons of mercury annually.

Yet, there is no reliable way to measure the amount that is recovered from this quantity, and the dental profession and related organizations that collect this waste also cannot account for this very large amount of material. Commonly these “chunks” are either “spit” down the drain and into the sewage system, swallowed by the patient (estimates of 17.5 tons of 10%18), thrown in the garbage where they enter the landfill, or disposed of as a biohazard which is incinerated, thus creating mercury vapor released to the air.

The author, a dentist himself, tried to establish some tracking method for how much of this type of waste is collected on an annual basis in Canada; however, there was no manageable way to calculate this to date.

d) Mercury waste from medium-sized amalgam particles

The fourth form of waste from amalgam placement is the particles larger than 1 cubic micron but smaller than 1 cubic mm. This size of particle is not as common in the initial placement of amalgam fillings as it is when amalgam fillings are being replaced.

These smaller scraps are not captured by the inline suction screens and normally make their way into the sewer, although recent recommendations on the use of amalgam separators are geared to prevent this size of particle from entering the environment.
e) **Mercury waste from small-sized amalgam particles and vapor**

The fifth form of waste from the insertion of amalgam fillings is sub-micron particles and mercury vapor. Mercury vapor from the actions of trituration, condensation (packing), and polishing commonly exceed maximum allowable occupational levels.\(^{19,20,21}\)

As a result, safety measures must be taken to avoid this contact. Sub-micron particles are more commonly released when amalgam fillings are removed, as discussed in the next section.

2) **Dental mercury released into the environment from amalgam that is placed in patients’ teeth:**

46% of the mercury used for dental amalgam is placed in the mouth, which adds to the existing societal stock.\(^{22}\) According to WHO’s estimates on global use of mercury in dentistry, this amount could reach as much as 184 tons a year (400 tons x .46).

The mercury presently stored in the mouths of U.S. population has been estimated at 1000 tons,\(^ {23}\) although this estimate is from 2004 and may be declining since more Americans are choosing non-mercury fillings and since the use of mercury in dentistry in developed countries has been declining over the last decade.

Applying the 2004 U.S. rate to the population of Canada would provide for an estimated additional 100 tons of mercury stored in the mouths of dental patients. Applying this rate to the population of the developed countries, especially because the populations of the developed countries account for majority of the current societal load, would result in a conservative estimate that the global stock of mercury in the mouths of humans is presently at approximately 4000 tons.

Here it should be noted that there is a lack of clarity as to whether the amalgam fillings present in teeth (societal load) are considered to be part of the environment:

If the definition of the *environment* is only the land, water, and soil, then one can consider the mercury placed in the mouth of a human as being “out of the environment.”

If, on the other hand, the definition of *environment* is taken from the 1988 edition of the Canadian Webster’s Dictionary, then the *environment* is also the “surrounding, especially the material and spiritual influences which affect the growth, development and existence of a living being.”\(^{24}\) This definition means that the womb of a mother is one of the most important environments there is, and therefore females that are (or potentially will be), mothers should be considered an essential part of the environment.

This definition also means that if all men, women, and children are recognized as “living beings,” then every person is part of the *environment*, which would mean that any and all dental mercury placed in any human tooth is “in the environment.”

Regardless of what definition of *environment* is used, all of the mercury placed in the tooth that is not removed by careful protocol and BPM is doomed to end up in the outside environment from excretion via feces, exhalation, urine, sweat, burial, or cremation.
While developing countries are generally exhibiting a gradual decrease in the use of mercury in dentistry, trends show that developing countries are in a position to create a much higher need for tooth restoration. If these teeth are restored with amalgam, there will be a concurrent increase in the use of mercury for dentistry. ²⁵

The societal store of mercury in amalgams has several secondary opportunities to be released into the environment, and these are discussed in the section below.

**Secondary Environmental Mercury Exposure from the Societal Load**

*Exhalation of mercury from placed dental amalgam as a source of air exposure*

The continuous vaporization of mercury from fillings in the mouths of humans creates much more of a dramatic impact on the environment than one might first consider.

First, the average filling has .5 gm of mercury, ²⁶ and the global societal store of mercury is estimated at 4000 tons (comprised of up to 8 billion fillings in peoples’ mouths worldwide).

Next, as indicated in the introduction, the amount of mercury vapor that comes off amalgam fillings in the mouth is dependent on many factors.

Quantifying the mercury emissions from fillings in patients’ mouths has been attempted by many researchers. A conservative estimate of mercury vapor given off an average filling is from 0.6 - 2.5 ug/filling/day. ²⁷ Using 1.5ug/filling/day as an average to calculate the amount of mercury vapor entering our air from existing fillings, the annual global amount released would be approximately 12 billion ug/day x 360 days/year or 4320 billion ug (4.32 tons).

Of this vapor, approximately 80% is absorbed into the body by inhalation. Therefore, the total mercury vapor exhaled from the societal load is 20% of the unabsorbed mercury on inhalation. ²⁸ Based on these estimates, 2.6 tons of mercury vapor is exhaled into the atmosphere annually from amalgam fillings, and about 1.7 tons are absorbed into the human body via the lung.

Recent studies by Mark Richardson used EPA standards to calculate that 67 million Americans exceed the reference exposure level for mercury established by the EPA. ²⁹

Richardson followed up the U.S. risk assessment with a Canadian risk assessment based on an extensive data set from Health Canada where he determined that over 80% of Canadians who have amalgam fillings exceed Health Canada Reference Exposure Level. ³⁰

*Mercury exposure from amalgam removal in societal load*

There are many reasons why amalgams are removed. In addition to hypersensitivity, metallic taste, restoration failure, and patient desire for superior esthetics, removal also occurs due to concerns about various medical conditions possibly associated with mercury exposure. ³¹ ³² ³³ ³⁴
Additionally, the average amalgam filling has a lifetime of 10 to 15 years, after which replacement is required.

Removal of old or unwanted fillings creates its own set of considerations with respect to the dispersion of mercury into the environment. This is largely because the routine technique of amalgam replacement requires removing the old filling with a high-speed dental drill. The action of the bur (bit) on the amalgam creates micron and sub-micron particles, as well as mercury vapor due to the heat of the drilling. It is well known that heated mercury vaporizes at a higher rate and poses a greater threat to the people and the environment.

Thus, the overall procedure of taking out amalgam fillings produces mercury debris that is very difficult to account for because bits and shards are commonly projected several feet from the operating site. These can end up in the patient’s and operator’s mouth, eyes, clothing, hair, or on the floor. It is estimated that 10% of this amalgam is swallowed by the patient, and the remaining majority of the waste, ends up in the sewage system through the eventual washing of hair, clothing, and floors, or via excretion.

Although the amount of mercury that is vaporized in this process is small percentage-wise, it can lead to levels ranging from .1 to 25 mg/m³ in the breathing space of both operators and patients. These levels exceed ceiling rates that are considered safe and lead to a significant increase in body burden of mercury in unprotected people working in the dental profession as well as their patients.

Alberta Occupational Standards (Alberta, Canada) allow no more than a 0.025 mg/m³ continuous exposure in an eight-hour working day and consider 0.125 mg/m³ mercury vapor to be the ceiling rate that is never to be exceeded for any duration. In addition, Alberta Occupational Standards consider mercury vapor to be a toxic substance readily absorbed through the skin, so protection for bare skin exposure at these levels is as important as avoidance of inhalation.

Common practices of amalgam removal in dental schools in the laboratory setting where dental students remove amalgam from plastic teeth, sometimes without precautions, have the potential to generate very high levels of mercury vapor.

Furthermore, during the process of removal, high volume suction is recommended to prevent occupational exposure, but many of these suction units are vented to the outside. The amount of mercury vapor that comes out of suction venting in American Dental Clinics may be as high as 1 ton annually. Any vapor that is not evacuated by the suction has the opportunity to increase societal load by being up taken by dental workers and patients.

There have been attempts to monitor dental clinic air for mercury vapor; however, because the exposures are localized and concentrated, the standard occupational room monitors for mercury vapor do not fully reflect the actual amount of mercury vapor or the occupational risk that exists in a dental clinic setting.
Dental professionals have demonstrated higher levels of mercury in their urine when compared to the general population. The culprit of this phenomenon is unknown, but it could be from mercury vapor releases, intake of micron and sub-micron particles, or both. At any extent, the production of particles of amalgam during removal creates an environment that can create a very significant occupational exposure to mercury, as well as patient exposure.

Studies have shown that the amount of amalgam particulate in the breathing space of patient and worker can equate to an inhalation rate of 19 mg per filling removed. Amalgam particulate is known to embed in the alveoli of the lungs where it is conducive to mercury disassociation. The mercury absorbed by this method is more likely to be elucidated in fecal samples rather than the urine. It has also been shown that even with the use of high volume suction and copious amounts of water, the amount of particulate that reaches the inhalation points of the dental worker is not reduced significantly from instances where these engineering controls are not used.

The reason for this large volume of inhalation exposure is that regular operative masks commonly used for dentistry are designed for the resistance of micro biota. Masks do not afford any protection from mercury vapor and also allow mercury particles as large as 3 microns to pass through them. It has been estimated that 68% of the particles that are created by drilling on an amalgam filling are .7 um or less, which means these small fragments containing mercury are inhaled by dental personnel.

Another hypothetical issue of the masks commonly used in dentistry today is that the amalgam particles that are caught in the mask are immediately exposed to warming by the exhalation of the operator. This rise in temperature increases the disassociation of mercury in the amalgam particles, and thus exposes the operator to more mercury vapor.

The particulate produced by dental drilling that is not absorbed by inhalation of the dental staff and/or patient and that does not end up in the operator masks, ends up trapped in the suction, and hopefully in an amalgam separator, or it is dispersed throughout the dental operating room.

This means that mercury particles are taken into the bare skin of any individual within the sub-micron plume, protective layers covering the patient, the dental equipment, the hair and clothing of the workers and their patients, and/or the floor of the clinic.

Because of all of these hazards, extra precaution must be taken to protect the patient and the dental staff. This includes the utilization of the non latex dental dam (latex is not impervious to mercury), mercury rated masks, face shields, alternative air sources for the patient, drapes on all bare skin, horizontal mercury suction units, high volume suction, copious amounts of water, the use of small diameter sharp bits (burs) and nitrile gloves.

The techniques involved in removing amalgam from teeth causes the same mercury-contaminated sundry burden as what was outlined earlier in the section entitled “Dental mercury released to the environment from amalgam waste (i.e. amalgam that is not in a patient’s tooth).”
The difference between the placement and the removal of amalgam fillings is that the removal causes a much larger ratio of smaller particles that are not captured in conventional suction screens. In North America, it appears that there are slightly more mercury amalgam fillings coming out of the mouth than going in, as the shift to non-mercury fillings in these jurisdictions occurs.

The decreasing placement of amalgam in developed countries causes a gradual decrease in the developed populations’ contribution to the amalgam societal load; however, this change creates a larger burden on the environment due to the removal of these mercury-based fillings. Extrapolating the numbers in Canada and applying them to other developed countries suggests that there could be as much as 200 tons of mercury drilled out of teeth each year.

Removal techniques have a profound effect on the environmental impact of this mercury. Dentists can reduce the burden on the environment, themselves, their staff, and their patients by using the drill bit to cross-hatch the old amalgam and “chunk” out the amalgam to retrieve these chunks by suction or by forceps. These larger chunks can then be placed into proper storage and disposed of in an environmentally-conscientious manner. The “chunking” also minimizes drilling and therefore reduces the production of micro and sub-micron particles and vapor. Using a generous water spray while drilling keeps the old amalgam filling cool and reduces the vaporization of mercury from the friction of the drilling. There are also special suction tips designed to increase the capture of mercury-laden aerosol produced by the dental drilling.

---The use of amalgam separators in preventing dental mercury releases---

Amalgam separators are likewise essential in reducing mercury releases to the environment, as they can reduce up to 99% of the small-sized particles that normally make their way to the sewer.

As such, after 14 years of an ineffective “voluntary” program to install amalgam separators, Canada has instituted a mandatory program for amalgam separators. However, these separators create an added expense to using amalgam, and the separators are only effective if they are maintained properly.

Amalgam separator maintenance creates another situation where human exposure to mercury can occur, and there are risks of spillage during maintenance of the separators and transportation of the waste collected in them. There are very few effective amalgam separator programs where both installation and maintenance are monitored, such as in the province of Ontario. Presently, there are very few jurisdictions in the U.S. where amalgam separators are mandatory, but efforts are underway to enforce their use. Several other developed countries including many European countries have embraced the use of separators.

Thus, although the maintenance of amalgam separators needs consideration and attention, at least their effectiveness in collecting some types of amalgam particulate has been well-established. Specifically, amalgam separators remove a significant amount of “fine” amalgam particles that would otherwise escape into the sewage system, which is known to be burdened by mercury discharge from dental offices. Yet, if the waste from the separators is not handled
properly, the particles that were collected could end up being released to the environment anyway.

Studies acknowledging the amount of dental waste emitted into sewage demonstrate the necessity for enforcement of amalgam separators and maintenance regulations, especially because much of the mercury amalgam in sewage sludge ends up being incinerated or spread on the soil as fertilizer, which again adds to the environmental burden.  

The impact of waste from amalgam into sewage treatment facilities is prolifically shown by evidence of the quantity of mercury releases to the water supply caused by dental offices. For example, the New York Academy of Sciences estimated that 40-60% of the mercury in the NY/NJ harbor was a result of dental office waste, and the Metropolitan Council Environmental Services for Minneapolis-St. Paul estimated the following breakdown of sources of mercury that their sewage system handled:

1) Industrial 5-10%
2) Residential 15-20%
3) Dental Sources 76-80%

While it is clear that the use of amalgam separators is essential for protecting the environment, the separators simply do not prevent all of the mercury releases into the environment by dental amalgam.

A study involving analysis of mercury containment in Ontario wastewater in 2002 calculated that roughly half of the amalgam removed from the societal load makes its way down the suction to the amalgam separator. So, what happens to the other half?

Based on statistics collected, about 1350 kgs of particulate are targeted for amalgam separator recovery while the additional portion finds its way into the sewer annually.

The remaining 1350 kgs of waste from amalgam removal, along with the other 2614 kg waste created by new fillings being placed (4665 kg - 2051 kg), must be accounted for. Although 1081 kgs of amalgam particulate are collected in the 1 mm screens during this study, 2883 kgs of amalgam are still missing from the equation.

This missing mercury likely consists of large chunks of amalgam that are collected, jarred, swallowed, or thrown in the waste. The unaccounted mercury may also be comprised of miniscule particles that are either inhaled, embedded in clothing, hair, and dental sundries, or trapped in the operatory, where cleaning procedures are likely to carry this waste into the sewer. Lastly, this unaccounted waste could be in the form of mercury vapor that is inhaled via the lungs or absorbed through the skin by dental staff and/or patients, or mercury that is heated and emitted as vapor to the atmosphere.

The point is that 2883 kgs of Canada’s mercury is left unaccounted for, even if amalgam separators are used. This is a significant amount which poses a serious hazard to the Canadian environment and the people in it, and this same practice is happening in other countries.
Secondary exposure of mercury from the amalgam societal load via extracted teeth

Many times when dentists remove teeth, the extracted tooth contains amalgam filling material. The fate of this mercury is not well-tracked, and there is inconsistency from jurisdiction to jurisdiction regarding the handling of an extracted tooth with an amalgam filling.

For an example, the most recent recommendations from Alberta Health Services advise that extracted teeth be placed in bio-hazardous containers. There is difficulty in classifying this biohazardous waste because extracted teeth contain a wide variety of micro biota, which has resulted in a recommendation to incinerate the waste. Yet, incineration is contraindicated for a material that contains mercury because it causes heat and thus more rapid mercury vapor releases to the environment.

There is still debate on how to best handle these situations; however, there appears to be only two solutions: 1) The tooth with mercury is placed in a landfill, risking mercury and microbiotic leaching, or 2) The amalgam is removed and placed in the “large chunk” sealed container that ultimately is taken to a recycling/storage facility, and the rest of the material is handled with consideration for micro-biotic leaching. The first scenario results in endangerment to the environment and landfill operators, and the second scenario endangers the person removing the amalgam. Both scenarios add an additional cost to the delivery of the amalgam filling service.

There is no data from any country that specifically tracks extracted teeth, let alone extracted teeth with amalgam fillings. It has been estimated that there could be up to 10 million extractions a year in the U.S. that are not for orthodontic purposes or wisdom teeth (unlikely to contain amalgam).

Considering that numerous teeth are removed because of pathology, and many times as many teeth are removed because of a “deep filling” that has abscessed, there are likely a substantial number of extracted teeth containing amalgam. Conservatively, if merely one-quarter of these teeth have amalgams, and each filling averages .5 gm, then a reasonable amount of mercury in extracted teeth would be in the hundreds of kilograms in America. Globally, this burden could be four times the American amount.

At any extent, there are no established protocols to protect the environment from mercury-containing extracted teeth, even though the releases are clearly substantial.

Secondary mercury exposure from the societal load via human excretion

Mercury can be excreted both via the feces or the urine. The ratio of the amount of mercury from dental mercury that is excreted in each of these two routes is variable from person to person and is dependant on a number of factors. Research has shown that the average person with amalgam excretes approximately 0.1 mg of mercury per day in his/her feces.92 In the United States, this amounts to over eight tons of mercury per year eventually being flushed out to sewers, streams, and lakes.93 Applying this rate to the developed population, the amount of mercury entering our sewers from this route possibly reaches 32 tons.94 95 96

It is estimated that for every amalgam surface in human teeth, the urinary mercury increases by
approximately 0.04µg/g-creatinine.\(^97\) From this one could calculate the urinary release that occurs from dental amalgam fillings.

**Mercury from amalgam in the saliva**

Mercury releases from the saliva of people with amalgam fillings would seem to be a small amount, but the analysis of these concentrations raises some essential considerations:

- First, the amount of mercury in saliva is directly related to number of fillings.\(^98\)
- Furthermore, the output of mercury vapor continuously emitted from amalgam fillings\(^99\) is dependent upon other activities associated with the human mouth, such as chewing (such as food and gum), teeth-grinding, and the consumption of hot liquids.\(^100\)\(^101\)
- Next, the production and the swallowing of saliva account for up to .5 to 1.5 litres per person, per day.\(^102\) The concentration of mercury in saliva in people with amalgam fillings commonly reaches more than 4.14 µg/ml,\(^103\) which is more than four times Health Canada’s allowable limit of 1 µg/l mercury concentration in water.\(^104\)
- Finally, the recommended consumption of water per person is 2-3 litres a day,\(^105\) but if the saliva of a person with mercury fillings was assessed for consumption, it would be declared unfit for drinking because of unacceptably high levels of mercury!

**Secondary mercury exposure from the societal load via cremation**

The amount of mercury that enters the environment from crematoriums is directly related to the amount of mercury contained in amalgam fillings,\(^106\) and the demographics of the population likewise correspond with this pollution. In the developed populations, as more elderly are keeping their teeth, there is a higher prevalence of mercury in the cremated body.\(^107\) Similarly, as the developed populations begin to reject amalgam and chose non-mercury containing filling material, the risk of mercury vapor being produced by cremation will be reduced.

Several researchers have proposed estimates of mercury releases during cremation. Mills in the UK estimated an average of 3 grams/cremation,\(^108\) and this estimate has been judged reasonable by Swiss\(^109\) and Swedish and Finnish\(^110\) researchers.

Another major factor is that many citizens in the developing populations are choosing cremation over burial. The Cremation Association of North America estimates that over 40% of deaths will be handled via cremation in 2010 in the U.S., and a U.S. estimate of mercury emissions from crematoriums prepared for EPA Region V by Barr Engineering and updated by EPA staff concurred. In the January 2006 version of this document, the estimate was that in 2005, there were 2,961 kilograms of dental mercury in the corpses cremated, and 75% (2,221 kg) of that mercury was released as air emissions, while 25% (740 kg) was released to the land.\(^111\) The primary source of the land emissions is mercury attached to settled particulates from the crematoria.\(^112\)
Overall, global amounts of mercury entering the environment via cremation can be conservatively estimated at 12 tons annually. Obviously, this amount of anthropogenic exposure requires attention, and it is not surprising that localities around the world have even begun fighting crematoriums in their neighborhoods due to fears of mercury releases.\(^{113}\)

Mercury release by cremation merits consideration of mandatory “extraction” of mercury-containing teeth prior to cremation and/or scrubbers in the stack to help protect the environment. This once again attaches an additional financial burden to the placement of amalgam fillings. Although these management practices can help reduce mercury exposure, one has to consider that scrubbers on stacks are not known to be 100% efficient. They are also extremely expensive. The practice of removing the mercury-containing teeth from the deceased not only increases the financial burden, but it also creates an increased need for storage, recycling, and/or handling, as well as an additional risk of exposure to the people that remove the teeth and/or amalgam.

*Secondary mercury exposure from the societal load via burial*

There are no studies on whether mercury from the fillings of the deceased who are buried leach out into the surrounding soil over time. Yet, a variety of burial methods would seem to cause environmental exposure.

Whether an individual is buried in a sealed casket, a cement vault, a tomb, or a shroud, inevitably bugs, worms, water, bacteria, and soil find their way into the area. A so-called “natural burial” (commonly promoted as a “green” resting place) actually seems to have higher potential for mercury exposure into the soil and water table since the body is not at all encased in this circumstance.

Any type of burial that promotes the oxidation of the body and the casket (if used) presents a greater risk of causing mercury contamination. If “green burials” gain popularity, then there is an urgent necessity for an established protocol to remove the mercury from the mouths of these bodies before they are placed in the earth.

One thing is clear: any mercury amalgam buried with a person impacts the soil, water, and animals in the vicinity.

*Motherhood as another secondary exposure of the societal load*

If environment is, as defined by the 1988 Canadian Webster’s dictionary as “the surrounding, especially the material and spiritual influences which affect the growth, development and existence of a living being”, then the mother or potential mother most certainly plays a major role in the “environment.”

Indeed, scientific studies have already proven the devastating impact of mercury on pregnant women and children, which is why pregnant women and children are advised not to eat certain types of seafood that might contain methyl mercury.\(^{114} 115 116\)
The dangers of fetal and infant exposure to mercury via maternal dental amalgam have likewise been scientifically established, and specific concerns have been raised about neurological issues, developmental delays, and cleft palate development.117 118 119 120 121 122 123 124 125 126 127

Furthermore, the most up-to-date science continues to expose the havoc that the mercury in dental amalgam fillings wreaks upon pregnant women and children. A study published in the April 2011 edition of *Environmental Monitoring and Assessment* notes, “As we showed, the number of amalgam filled teeth in breast-feeding mothers strongly influences the mercury level in their milk. Take it into consideration that maternal milk is the only source of nutrition during the first few months after birth.”128

Another recent study published in *Science of the Total Environment* cautions, “Changes in dental practices involving amalgam, especially for children, are highly recommended in order to avoid unnecessary exposure to Hg.”129

Perhaps the best summation of using mercury in products for children was made at the 2010 United States Food and Drug Administration’s Dental Product Panel hearings by Dr. Suresh Kotagal, a pediatric neurologist at the Mayo Clinic, when he announced, “There is really no place for mercury in children.”130

Meanwhile, mercury has suspected as a factor in autism,131 132 133 134 135 136 137 138 139 140 and as such, maternal dental amalgam fillings have been linked to autism as well.”141 142 143 144 145

**Closing Statements**

A peak of mercury use in 70’s has been recognized, and since dental amalgam use began in the mid 1800’s, there has been very little attention given to the environmental impact of this material until the last 15-20 years.

Because dental amalgams require replacement every 15 years or so, it can be argued that the majority of mercury used in dentistry from its initial use up until 1995 is functionally “in the environment.” The only mercury that was recaptured during this time would be the large chunks of amalgam waste that dentists might have collected. The rest of the mercury is inevitably released in the soil, air, water, and patients. There is not enough data to calculate this burden, but an educated guess would put the number in the thousands of tons.

This mercury released from dental amalgam exists in all facets of the environment, and it exists in many forms. It may exist as an amalgam particle continually vaporizing mercury, it may exist as inorganic mercury, or it may have been converted into methyl mercury by a number of organisms that have this potential.

Considering this, it may be a moot point to separate the methyl mercury from the consumption of fish and the inorganic mercury that is produced by mercury vapor. There is a real possibility that because of the magnitude of mercury pollution created by dental amalgams, the mercury in fish might have originated from dental amalgam filling material.
It is concerning that although the developed countries are beginning to understand and act upon the environmental mercury hazard created by amalgams, there is a population three times the size of the developed population that is just beginning to enter a phase requiring extensive dental restoration.

It is also clear that a true global phase down of dental amalgam would assist in a smoother, safer, and more economical transition to a healthier world without so many mercury releases to the environment. The filling alternatives are already in place, and there are organizations such as The International Academy of Oral Medicine and Toxicology and countries such as Norway, Sweden, and Denmark that are willing to assist in this changeover.


5 Ibid.

6 Ibid.

7 Ibid.


9 Ibid.

10 Ibid.

11 Ibid.


16 Ibid.

17 Ibid.

18 Ibid.

19 Ibid.

20 Ibid.

21 Ibid.

22 Ibid.

23 Ibid.

24 Ibid.

25 Ibid.

26 Ibid.


26 Ibid.
28 Ibid.
29 Ibid.


79 Ibid.


82 Ibid.

83 Ibid.

84 Ibid.


86 Ibid.


Ibid.


Ibid.


Numerous examples of this exist, as you can see simply by internet searching for news stories about communities fighting crematoriums and crematoria being required to reduce mercury emissions. Here are several:

- http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2006/07/07/BAG7OJOPDC1.DTL&ao=all
- http://www.dailymail.co.uk/news/9613140.Dated_crem_facilities_to_get_1m_overhaul

http://www.epa.gov/hp/exposure.htm


147 United Nations Environmental Programme. [UNEP (DTIE)/Hg/INC.4/3 -] “Revised draft text for a comprehensive and suitable approach to a global legally binding instrument on mercury” Draft text accessed online 13 April 2012 at http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/INC4/4_3_drafttext_advance.doc
The Minamata Convention on Mercury: Attempting to address the global controversy of dental amalgam use and mercury waste disposal

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HIGHLIGHTS

• The Minamata Convention on Mercury is a new global health and environment treaty.
• The Convention calls for a phase down of dental fillings using mercury amalgam.
• It includes voluntary measures but fails to establish binding targets on a phase down.
• Future review should include exploration of ways to strengthen implementation.
• Strengthening the Convention ensures oral health access and environmental stewardship.

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ABSTRACT

In October 2013, a new international binding treaty instrument called the Minamata Convention on Mercury opened for signature in Minamata City, Japan, the site of arguably the worst public health and environmental disaster involving mercury contamination. The treaty aims to curb the significant health and environmental impacts of mercury pollution and includes provisions addressing the mining, export and import, storage, and waste management of products containing mercury. Importantly, a provision heavily negotiated in the treaty addresses the use of dental fillings using mercury amalgam, an issue that has been subject to decades of global controversy. Though use of dental amalgam is widespread and has benefits, concerns have been raised regarding the potential for human health risk and environmental damage from emissions and improper waste management. While the Minamata Convention attempts to address these issues by calling for a voluntary phase-down of dental amalgam use and commitment to other measures, it falls short by failing to require binding and measurable targets to achieve these goals. In response, the international community should begin exploring ways to strengthen the implementation of the dental amalgam treaty provisions by establishing binding phase-down targets and milestones as well as exploring financing mechanisms to support treaty measures. Through strengthening of the Convention, stakeholders can ensure equitable access to global oral health treatment while also promoting responsible environmental stewardship.

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1. Introduction

The global debate regarding the environmental and health impact of dental amalgam containing mercury (Hg) is rapidly moving toward consensus with the recent adoption by 139 countries of an international binding treaty instrument (UNEPC 2013c), the United Nations Environment Programme ("UNEP") Minamata Convention on Mercury ("Minamata Convention") (Environmental Health Department, 2002). This Convention could have a lasting impact on the future of global oral health.

Dental amalgam - a dental restorative filling material alloy that consists of approximately 50% mercury with the balance including silver, tin, copper, and zinc and other trace metals – has been used for centuries by dentists globally to restore teeth diseased by dental caries (FDA, 2009b; Bharti et al., 2010). Its use in dental amalgam represents the most common form of human exposure to elemental mercury (recognized as a toxic substance) and along with its use in laboratory/medical devices, comprises 53% of total global mercury emissions leading to potential environmental damage (WHO, 2005). Despite ongoing concerns about human health effects, the use of dental amalgam containing mercury continues to be widespread given its potential benefits
and cost-effectiveness, though in some regions it is showing declines in use (Bharti et al., 2010). With the vast majority of the world’s population afflicted by dental caries, the importance of ensuring adequate and safe access to oral health treatment options has made this an important global public health issue (British Dental Journal, 2004; WHO, 2004).

Advocates of using dental amalgam as a dental restorative material cite its low cost, ease of manipulation and placement, durability, and historical record of safety (Bharti et al., 2010; Rathore et al., 2012; Dodes, 2001). Opponents point to its unattractive appearance, potential to weaken tooth structure, release of mercury vapor and particles, potential occupational hazard to dental staff, growing availability of alternative composite fillings, and negative environmental impact from waste disposal (Mutter, 2011; Hörsted-Bindslev, 2004; Mutter et al., 2005; WHO, 2005). Consequently, ongoing controversy regarding continued use of dental amalgam containing mercury has primarily focused on two distinct but related issues: the potential human health impact from mercury exposure and the environmental impact of medical mercury-related waste.

Below, we examine the current international debate and potential future use of mercury in dental amalgam. We discuss ongoing human health and environmental concerns and provide policy analysis of the Minamata Convention in response to these issues. Based on these analyses, we then formulate suggestions on how the Convention could be strengthened and better implemented to promote global oral health and ensure environmental stewardship.

1.1. Global dental amalgam controversy

A primary but unresolved concern of dental amalgam use is its potential impact on population-based health given its widespread use in dentistry. From the perspective of patient safety, it is largely undisputed that intraral amalgam fillings lead to continuous vapor exposure from elemental/inorganic mercury, an element that is recognized for its toxicity and has been associated with a number of adverse health outcomes (including neurological and renal effects) primarily observed in occupational settings (Richardson et al., 2011; Bernhoff, 2012; Park and Zheng, 2012; Mutter et al., 2005).

Yet the amount/dose of mercury exposure occurring from dental amalgam use and its consequential health impact remains in sharp dispute, with absorption rates also shown to vary based on individual behavior (e.g., chewing, brushing, bruxism) as well as other factors (Richardson et al., 2011; WHO, 2003). Though studies have shown a positive correlation between the number of dental amalgam restoration surfaces and the levels of mercury in human blood, tissue, and urine, whether such exposure equates to significant negative health risk is still under debate and requires further study (FDA, 2009a; Nylander et al., 1987).

From an environmental perspective, methylmercury has been globally recognized as an environmental toxin by organizations including the UNEP, the World Health Organization (“WHO”), the International Labour Organization, and the US Environmental Protection Agency. Specifically, mercury medical-related waste occurring from extracting, disposing and incineration of dental amalgam and from human cremation has been found to contaminate the atmosphere, land, water sources, and waste-water (WHO, 2005; Hörsted-Bindslev, 2004). Yet, sovereign responses to dental-related mercury environmental contamination have been uneven and are largely influenced by varying national or local regulations on medical waste disposal, particularly with the absence of an international binding agreement (Spencer, 2000). For example, countries including Norway and Denmark have banned the use of mercury in dental amalgam over concerns of environmental impact, with Sweden joining this ban on the grounds of both environmental and health concerns (Richardson et al., 2011; Reuters, 2008; Lynch and Wilson, 2013). Other countries, such as the USA, may lack national legislation on dental mercury disposal, but may have local or state regulations (e.g., New York State) that require specific disposal and recycling requirements (New York State Department of Environmental Conservation, n.d.).

Similarly, professional dental societies have issued their own policy statements regarding the use of dental amalgam containing mercury in an effort to influence international negotiations on the Minamata Convention. The World Dental Federation (“FDI”), a non-governmental organization with approximately 200 national member associations and specialist groups from more than 130 countries representing over 1 million dentists worldwide, has come out in favor of amalgam as a safe and effective restorative material, only calling for a gradual reduction (FDI, 2013b). Joining FDI’s policy stance was also the American Dental Association (“ADA”), the largest and oldest dental organization in the USA representing some 157,000 members. The ADA’s official position is that dental amalgam is affordable, durable, and possesses a long record of safety and effectiveness (ADA, n.d.). In contrast, other smaller advocacy groups, such as the World Alliance for Mercury-Free Dentistry and the International Academy of Oral Medicine and Toxicology, have favored a ban on dental amalgam and also participated in treaty discussions advocating for this position (ISD, 2013).

These conflicting perceptions, positions, and policies addressing the health and environmental impacts of dental amalgam that vary by country and stakeholder, have led to an ongoing global “amalgam controversy” with some stakeholders advocating for its continued unrestricted use, and others calling for a complete global ban (Rathore et al., 2012; Richardson et al., 2011; Bharti et al., 2010). Yet for middle and low income countries that increasingly face challenges in dental treatment capacity and availability of resources, a complete ban on mercury amalgam or switch to more costly composite materials may not be currently feasible (WHO, 2009). Due in large part to this concern, international organizations such as the WHO have suggested a “phasing down” strategy to bring a more gradual approach to addressing the diverse public health, environmental, and economic concerns of mercury dental amalgam (WHO, 2009; Harrison, 2011).

2. The Minamata Convention

Ongoing debate regarding the future use of dental amalgam in global oral healthcare and exploring a phase-down strategy has been the subject of international public health and environmental discussions. In 2009, the governing council of the UNEP requested the formation of an Intergovernmental Negotiating Committee to examine ways to reduce the risk to human health and to the environment from the use and release of mercury, including in dental amalgam (UNEP, 2009). This process concluded in January 2013, with national governments agreeing to the text of the Minamata Convention during the 5th session of the committee, and the recent opening of the treaty for signature in October 2013 (UNEP, 2013c). As of early November 2013, 93 countries have become signatories to the treaty and one country, the United States, has ratified. The Minamata Convention will come into force after 50 countries have ratified (UN News Centre, 2013).

The Minamata Convention was named after the neurological syndrome caused by severe mercury poisoning from consumption of contaminated seafood known as “Minamata disease”. The disease was first identified in Minamata City, Japan in 1956, where mercury contamination released through industrial waste water led to a public health disaster resulting in thousands of deaths as well as a congenital form of the disease (Tsuda et al., 2009). Included in the treaty are a number of controls regarding mercury mining, import and export, storage, disposal, and reducing mercury emissions (UNEP, 2013b). The treaty also includes commitments to health promotion and education, healthcare capacity building, technical assistance, and technology transfer with special consideration for least developed countries (UNEP, 2013b). The most powerful provisions of the treaty are the institution of a global ban on the import and export of certain products containing mercury (including batteries, switches/relays, fluorescent lamps, soaps/
cosmetics) set to commence in 2020 (UNEP, 2013b). However, exempted from the 2020 ban are dental amalgam fillings using mercury (UNEP, 2013b).

Instead, Article 4, Paragraph 3, Part II: Products subject to Article 4, Paragraph 3, of the Minamata Convention specifically addresses dental amalgam by calling on countries that sign and eventually ratify the Convention to phase-down the use of dental amalgam taking into account their own “domestic circumstances and relevant international guidance” and generally committing to two or more measures outlined in the treaty (UNEP, 2013b). These include:

(i) Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration;
(ii) Setting national objectives aiming at minimizing its use;
(iii) Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;
(iv) Promoting research and development of quality mercury-free materials for dental restoration;
(v) Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices;
(vi) Discouraging insurance policies, and programs that favor dental amalgam use over mercury-free dental restoration;
(vii) Encouraging insurance policies and programs that favor the use of quality alternatives to dental amalgam for dental restoration;
(viii) Restricting the use of dental amalgam to its encapsulated form;
(ix) Promoting the use of best environment practices in dental facilities to reduce releases of mercury and mercury compounds to water and land.

The measures agreed upon represent the culmination of 4 years of negotiations on this controversial issue. During this time, some country representatives called instead for a strengthening of restrictions on dental amalgam with other policy alternatives including: 1 — proposing a binding phasing out by 2025 with polluters bearing the cost of disposal and management; and 2 — a complete ban given availability of other alternatives (UNEP, 2013a). Ultimately, countries agreed to the language contained in the negotiated treaty draft. However, upon more detailed examination, these text and alternatives therein are generally non-binding, have no specified time frame for phasing-down use, and only require voluntary commitment on 2 out of 9 total recommended measures.

In response to conclusion of the treaty discussions, dental stakeholders such as the FDI and the ADA that lobbied against a binding phase-down announced their support of the final negotiated Minamata Convention provisions. Specifically, FDI has called for support of a general phase-down approach based on prevention, research for alternative materials, and waste management practices (FDI, 2013a). The ADA also supports the treaty based on the ADA’s position of the overall safety of dental amalgam and that continued amalgam use will not be subject to any binding restrictions under the Convention (ADA, 2013).

3. Strengthening the Minamata Convention

The Minamata Convention has many positive elements supported by dental associations that have the potential to improve global oral health and address the environmental impact of mercury-related disposal. These include strengthening oral health through national prevention programs, investment in research & development for alternative materials, development of economic incentives for use of alternatives, promotion of environmental waste and disposal controls, and training and education of dental health professionals. However, the absence of binding and measurable requirements may pose challenges in effectively implementing the intent of the treaty and ensuring harmonized environmentally-sound management.

Specifically, lack of a binding phase-down date with quantifiable targets for reduction of mercury-based dental amalgam use makes the provision virtually impossible to enforce even if a party signs on and ratifies the treaty. Additionally, permissive language allowing countries to defer to their own “domestic circumstances” provides a broad exclusion that will undoubtedly lead to countries deprioritizing any commitments under the treaty due to potential domestic pressures that may be politically and/or economically focused rather than public health or environmentally-based. Further, countries may selectively pick and choose low resource/low impact measures or may simply point to measures already implemented as fulfilling treaty measures to minimize further commitments and resource allocation. As an example, only Subsections (v) and (ix) of the treaty provision specifically addresses waste and environmental-related controls for dental amalgam use and management, despite the fact that these measures are the primary purpose of the treaty.

Perhaps most importantly, there appears to be no specific funding mechanism to support the amalgam treaty measures and national programs recommended by it. Though pre-ratification activities of the treaty are generally supported by the Global Environment Facility, there does not appear to be a clear pathway for a sustainable funding mechanism specific to dental amalgam provisions (GEF, 2013). This would make it difficult to incentize the development of alternative materials/reimbursement mechanisms or implementation of occupational health standards and waste management processes, especially for low-income countries and may provide a disincentive for phasing-down. Instead, a more dynamic global health policy solution to strengthen implementation of the Convention should be explored that takes into account the need for some measurable phase-down of mercury amalgam use given its clear environmental impact while also recognizing the need to ensure continued access to this form of dental treatment to those patients where no feasible alternative is available (Table 1).

Such a solution should include a tiered phase-down on mercury amalgam use. This approach can be based upon a country's oral health disease burden, income group, and dental treatment capacity, with poorer countries allowed more long-term phase-down periods compared to richer industrialized countries. This would be similar to provisions contained in the World Trade Organization Trade Related Aspects of Intellectual Property Rights Agreement, that have permitted least developed countries time extensions to implement treaty-bound obligations for global intellectual property rights (Mackey and Liang, 2012b). Any phase-down period should also include tangible milestones, including quantifiable reductions in mercury emissions, possible national adoption of use of amalgam separators, implementation of dental protocols for safe amalgam removal and disposal, and development of all party-transition task groups or public–private partnerships for amalgam waste management such as the UNEP–WHO–FDI–International Dental Manufacturers initiative that is being piloted in Africa (FDI, 2013c; Lynch and Wilson, 2013).

Using the tiered programmatic approach, financing mechanisms could be put in place so that “excess” polluters within a country, using the tiered treaty standard, that fail to meet their respective targets would pay penalties to their national governments for non-compliance. Countries could then earmark these funds for investment in the measures set forth in the Convention, including promoting preventive care national oral health programs, a mechanism similar to that suggested in the literature for the Nagoya Protocol on biodiversity and bioprospecting (Mackey and Liang, 2012a). A portion of these funds could also be allocated to a centralized fund administered by the UNEP and the Convention’s Conference of Parties (“COP”) in support of Convention goals, including actively engaging in capacity building for oral health and environmental waste management in countries that lack adequate resources.

This policy proposal could be considered at the 5 year implementation review by the COP, which allows for amendment of the provision for dental amalgam contained in Annex A, Part II of the Convention.
taking into account additional research on the health and environmental impacts of dental amalgam and availability of alternative dental materials (UNEP, 2013b). If at that time tangible efforts toward mercury emission reductions from dental amalgam use have been achieved, then these recommendations can be implemented as guidance under the treaty as well as serve as important case studies for implementation lessons for other similarly situated countries. If efforts have not been adequately pursued, then binding targets and requiring countries to meet tangible outputs for the measures such as those suggested should be explored, and analyses of failure modes should also be engaged for future efforts at treaty implementation.

4. Conclusion

The adoption, opening for signature and ratification of the Minamata Convention represents important international recognition of the potential dual harms of using mercury dental amalgam from a human health and environmental perspective. Yet, the use of dental amalgam will invariably continue as the need to provide access to equitable and affordable oral healthcare has never been greater. This necessitates a measured approach to a global dental amalgam phase-down under the new treaty. This can be accomplished by starting discussions on how to dynamically strengthen implementation of the Minamata Convention in order to ensure safe and environmentally-sound global oral healthcare that can finally begin to bring resolution to the debate over dental amalgam.

Conflicts of interest declaration and funding source statement

All authors declare that they have had no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; and no other relationships or activities that could appear to have influenced the submitted work. In addition, no third party has prompted any of the authors to write this article; and no additional author/professional writer contributed to the article. These were no funding sources for this manuscript.

References


YOU NOW NEED TO VISIT IAOMT’S “ONLINE LEARNING CENTER” TO WATCH THE ENVIRONMENTAL IMPACT OF DENTAL MERCURY VIDEO AT https://iaomt.org/online-learning/environment/.

IF CLICKING ON THE LINK ABOVE DOES NOT WORK, THE VIDEO IS LOCATED ON THE IAOMT WEBSITE (WWW.IAOMT.ORG), ON THE TAB FOR “MEDIA AND RESOURCES,” AND ON THE SUB-TAB FOR “ONLINE LEARNING CENTER.” ONCE IN THE ONLINE LEARNING CENTER, CLICK ON “FREE ONLINE LEARNING,” AND THEN VIEW THE “ENVIRONMENTAL IMPACT OF DENTAL MERCURY” VIDEO.

UPON COMPLETION OF THE “ENVIRONMENTAL IMPACT OF DENTAL MERCURY” VIDEO, YOU WILL NEED TO CONTINUE WITH THE ADDITIONAL REQUIREMENTS FOR UNIT 6, WHICH INCLUDE MORE READINGS AND COMPLETING THE UNIT 6 TEST.
Fact Sheet: Effluent Limitations Guidelines and Standards for Dental Offices

Summary
EPA finalized technology-based pretreatment standards under the Clean Water Act to reduce discharges of mercury and other metals from dental offices into municipal sewage treatment plants known as publically owned treatment works (POTWs). Dental offices, which discharge mercury and other metals present in amalgam used for fillings, are the main source of mercury discharges to POTWs; these metals are subsequently released to the environment. The rule requires dental offices to comply with requirements based on practices recommended by the American Dental Association, including the use of amalgam separators. Once captured by the separator, dental amalgam can be recycled. Removing mercury when it is concentrated and easy to manage, such as through low-cost amalgam separators at dental offices (average annual cost per dental office is about $800), is a common sense solution to managing mercury that would otherwise be released to air, land, and water.

EPA expects compliance with this final rule will reduce the discharge of metals to POTWs by at least 10.2 tons per year, about half of which is mercury.

EPA projects the total annual cost of the final rule will be $59 - $61 million.

Background

Why are standards needed for the dental industry?
When dentists remove old amalgam fillings from cavities, or when dentists place a new filling, mercury in the form of dental amalgam enters the wastewater of the dental office. Mercury from waste amalgam can make its way into the environment from the POTW through the incineration, landfiling, or land application of sludge or through surface water discharge. Mercury is a potent neurotoxin that can have a wide range of health effects, and mercury pollution is a global concern. Once released into the aquatic environment, certain bacteria can change mercury into methylmercury, a highly toxic form of mercury that bioaccumulates in fish and shellfish. Eating fish and shellfish is the main source of people’s exposure to methylmercury in the U.S.

Who is affected by this regulation?
This rule applies to offices, including large institutions such as dental schools and clinics, where dentistry is practiced that discharge to a POTW. It does not apply to mobile units or offices where the practice of dentistry consists only of the following dental specialties: oral pathology, oral and maxillofacial radiology, oral and maxillofacial surgery, orthodontics, periodontics, or prosthodontics.
Control Authorities (which are often the state or POTW) are responsible for oversight associated with this rule.

**What does this rule require of dental offices?**

Dental offices that discharge to POTWs that do not place or remove amalgam need only submit a one-time certification.

Dental offices that place or remove amalgam must operate and maintain an amalgam separator and must not discharge scrap amalgam or use certain kinds of line cleaners. They must also submit a One-Time Compliance Report.

**Where can I find more information?**

You can access the Federal Register notice on EPA’s Effluent Guidelines website at: [www.epa.gov/eg/dental-effluent-guidelines](http://www.epa.gov/eg/dental-effluent-guidelines). In addition, the final rule will be available at [regulations.gov](http://regulations.gov) under Docket ID: EPA-HQ-OW-2014-0693.

You may also email Karen Milam at milam.karen@epa.gov.

**IAOMT NOTE: To learn more from the EPA about this guideline, visit https://www.epa.gov/eg/dental-effluent-guidelines**
YOU NOW NEED TO TAKE THE UNIT 6 TEST AT https://www.cvent.com/d/6vq54n.

IT IS AN OPEN BOOK TEST AND CONSISTS OF 25 QUESTIONS. YOUR SCORE WILL BE AUTOMATICALLY CALCULATED AND SENT TO YOU VIA EMAIL.

UPON COMPLETION OF THE UNIT 6 TEST, YOU WILL NEED TO CONTINUE WITH THE REST OF THE ACCREDITATION REQUIREMENTS. ACCESS THE MATERIALS FOR UNIT 7 BY USING THE LINK TO THE IAOMT COURSE PDFs AT https://iaomt.org/accreditation-materials/.