



**International Academy of Oral Medicine and Toxicology
(IAOMT)
Position Paper against Dental Mercury Amalgam Fillings
for Medical and Dental Practitioners, Dental Students,
Dental Patients, and Policy Makers**

Originally Released on April 16, 2013
 First Update on March 2, 2016; Second Update on July 23, 2019, Third Update on
 May 26, 2022.
 Regulations Update on October 6, 2020

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Originally Approved by the IAOMT Board of Directors on March 14, 2013;
 First Update Approved on March 10, 2016; Second Update Approved on July 23, 2019
Table of Contents:

Introduction-----Pages 2-7
 Position Paper Objectives, Page 2
 Regulations Overview, Page 2
 International Regulations, Pages 2-3
 U.S. Regulations--States, Page 4
 U.S. Regulations--Environmental Protection Agency (EPA), Page 4
 U.S. Regulations--Occupational Safety and Health Administration (OSHA), Pages 4-5
 U.S. Regulations--U.S. Food and Drug Administration (FDA), Pages 5-6
 IAOMT’s Position on Regulations, Pages 6-7
 Suggested Action by Medical and Dental Practitioners and Patients-----Pages 7-23
 Interventions, Pages 7-11
 Outcomes Considered--Individual Response, Page 11-13
 Outcomes Considered--Amalgam Removal, Pages 14-16
 Outcomes Considered--Alternatives to Amalgam, Pages 16-17
 Outcomes Considered--Susceptible Populations, Page 18
 Major Recommendations, Pages 19-21
 Additional Data Supporting Recommendations, Pages 22-23
 Evaluation of Suggested Action-----Pages 24-30
 Potential Benefits, Pages 24-25
 Potential Harms, Page 26-27
 Contraindications, Page 27
 Qualifying Statements, Pages 27-30
 Description of Implementing Suggested Action and Resources-----Page 30
 Disclaimer-----Page 31
 Affiliations and Professional Degrees of Authors-----Page 31
 Endnotes-----Pages 32-91

INTRODUCTION

Position Paper Objectives:¹

- 1) To end the use of dental mercury amalgam fillings. Many other mercurial medical devices and mercury-containing substances have been removed from use, including mercurial wound disinfectants, mercurial diuretics, mercury thermometers, and mercurial veterinary substances. In this era when the public is advised to be concerned about mercury exposure through fish consumption, dental mercury amalgam fillings should also be eliminated, especially because they are the predominant source of non-industrial mercury exposure in the general population.
- 2) To assist medical professionals and patients as a whole in understanding the scope of mercury hazards from dental mercury amalgam fillings. The risk of illness or injury associated with the use of dental mercury presents an unreasonable, direct, and substantial danger to the health of dental patients, dental personnel, and the fetuses and children of dental patients and dental personnel.
- 3) To establish the health benefits of mercury-free, mercury-safe, and biological dentistry.
- 4) To educate dental and medical professionals, dental students, patients, and policy makers about safe removal of dental mercury amalgam fillings, while raising the standards of scientific biocompatibility in dental practice.

Regulations Overview:

According to the [United States Food and Drug Administration](#) (FDA), “Dental amalgam is a mixture of metals, consisting of liquid (elemental) mercury and a powdered alloy composed of silver, tin, and copper. Approximately 50% of dental amalgam is elemental mercury by weight. The chemical properties of elemental mercury allow it to react with and bind together the silver/copper/tin alloy particles to form an amalgam. Dental amalgam fillings are also known as ‘silver fillings’ because of their silver-like appearance. Despite the name, ‘silver fillings’ do contain elemental mercury.”²

Millions of dentists around the world routinely use dental mercury amalgam to repair decayed teeth, but controversy has surrounded the use of mercury in dentistry since the 1800’s, when the neurotoxin was first widely introduced as a filling material. The American Society of Dental Surgeons, the predecessor to the American Dental Association, [made its members pledge not to use mercury because of its known toxicity](#),³ and in more recent years, government officials, scientists, dentists, consumers, and many others have raised serious concerns about the risks dental mercury poses to humans and to the environment at large.

International Regulations:

The United Nations Environment Programme’s Intergovernmental Negotiating Committee agreed upon the text of a global, legally-binding mercury treaty in 2013, and over 100 nations have since signed the “[Minamata Convention on Mercury](#).” The United States was the first country to give its support for ratification of the international agreement, which entered into force in 2017. Annex A, Part II, includes the following initiatives with regards to dental mercury amalgam:⁴

- (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.⁵

As part of the Minamata Convention on Mercury, the European Parliament voted in March 2017 to reduce dental mercury use. In addition to reporting “on the feasibility of a phase out of the use of dental amalgam in the long term, and preferably by 2030,”⁶ [the new European Union regulation](#) includes the following measures:

1. From 1 January 2019, dental amalgam shall only be used in pre-dosed encapsulated form. The use of mercury in bulk form by dental practitioners shall be prohibited.
2. From 1 July 2018, dental amalgam shall not be used for dental treatment of deciduous teeth, of children under 15 years and of pregnant or breastfeeding women, except when deemed strictly necessary by the dental practitioner based on the specific medical needs of the patient.
3. By 1 July 2019, each Member State shall set out a national plan concerning the measures it intends to implement to phase down the use of dental amalgam.⁷

A number of countries have likewise taken action against the use of dental mercury amalgam fillings. A [2017 report from the United Nations Environment Programme](#) establishes that the following measures have been taken around the globe:

- In Norway and Sweden, dental amalgam is no longer in use.
- In Japan, Finland and the Netherlands, dental amalgam is being phased out.
- In Mauritius and the European Union, dental amalgam is banned from use on children.
- Denmark uses dental amalgam for only 5 per cent of restorations, and Germany for about 10 per cent.
- In Bangladesh, dental amalgam is to be phased out in 2018.
- In India, dental schools are required to eliminate amalgam in favor of mercury-free alternatives.
- In Nigeria, the government has printed and distributed consumer information brochures promoting mercury-free alternatives to amalgam.
- The government of Canada has recommended that dentists not use amalgam for children, pregnant women and persons with kidney disorders.⁸

U.S. Regulations--States:

In the United States, brochures have been created to educate patients about their choices for dental fillings in [California](#),⁹ [Connecticut](#),¹⁰ [Maine](#),¹¹ and [Vermont](#).¹² The brochures, some of which are legally required to be presented to dental patients, contain information about the release of mercury vapor from dental mercury amalgam fillings and concerns related to dental mercury amalgam usage.

U.S. Regulations--Environmental Protection Agency (EPA):

Recently, the U.S. Environmental Protection Agency (EPA) utilized measures in the Clean Water Act to develop standards for dental offices/clinics to use amalgam separators so that dental mercury is not flushed down the drain and into the environment.¹³ EPA estimates about 103,000 dental offices use or remove amalgam in the U.S. and that almost all of these send their wastewater to POTWs [publicly owned treatment works].¹⁴ [The new guidelines](#) went into effect in July 2017, and the EPA has estimated that it could reduce the discharge of mercury by 5.1 tons annually.¹⁵

U.S. Regulations--Occupational Safety and Health Administration (OSHA):

Employee exposure to mercury is regulated in the United States by the [1970 Occupational Safety and Health Act](#)¹⁶ and [Workers' Rights Handbooks](#)¹⁷ from the United States Department of Labor's Occupational Safety and Health Administration (OSHA), which establish that all employees have the right to know about the chemicals in their work environment. OSHA's Hazard Communication Standard (HCS) states: "All employers with hazardous chemicals in their workplaces must have labels and safety data sheets [SDS] for their exposed workers, and train them to handle the chemicals appropriately. The training for employees must also include information on the hazards of the chemicals in their work area and the measures to be used to protect themselves."¹⁸

The purpose of the safety data sheets (SDS, formerly known as material safety data sheets, or MSDS) required by OSHA is to protect workers by supplying them with the most crucial facts about the hazardous materials at their jobsite, such as the physical properties of the material, proper storage and handling techniques, known health risks and essential emergency procedures. Thus, manufacturers of amalgam fillings must create these information sheets, and excerpts from just a few of the SDSs for dental amalgam includes compelling evidence about the known dangers of using mercury in fillings:

- [SDI; Permite; Lojic +; GS-80, GS-80 Spherical; F400; Ultracaps +; Ultracaps S; SDI Admix; SDI Spherical and New Ultrafine.- Capsules](#); Australia, Brazil, Ireland, and the USA; 2015:¹⁹
 - Hazard Identification/California Prop 65 Warning: "This product contains mercury, a chemical known to the State of California to cause birth defects or other reproductive harm."
 - First Aid Measures: "May cause respiratory disorders including inflammation and fluid retention. Inhalation of mercury vapours at high concentration can cause dyspnea, coughing, fever, severe nausea, vomiting, excess salivation, kidney damage with renal shutdown."

- Toxicological Information/Chronic Health Effects: “Inhalation of mercury vapours, dusts or organic vapours, or skin absorption or mercury over long periods can cause mercurialism. Symptoms include tremors, inflammation of mouth and gums, excessive salivation, stomatitis, blue lines on gums, pain and numbness in extremities, weight loss, mental depression, and nervousness. Exposure may aggravate kidney disorders, chronic respiratory disease and nervous system disorders. May cause damage to blood, kidneys, liver, brain, peripheral nervous system, central nervous system.”
- [Kerr Corporation; Tytin FC™](#); USA; 2014.²⁰
 - First Aid Measures/Inhalation: “Adverse symptoms may include the following: reduced fetal weight, increase in fetal deaths, skeletal malformations, salivation, metallic taste, eye irritation, respiratory tract irritation, coughing, pulmonary edema, wheezing and breathing difficulties, headache, fever, nausea or vomiting, diarrhea, abdominal cramps and pain, muscle weakness / pain, mental confusion or disorientation.”
 - First Aid Measures/Skin Contact: “Adverse symptoms may include the following: reduced fetal weight, increase in fetal deaths, skeletal malformations.”
 - First Aid Measures/Ingestion: “Adverse symptoms may include the following: reduced fetal weight, increase in fetal deaths, skeletal malformations.”
- [Henry Schein; SDS acc. to OSHA HCS/GHS; Stratosphere, Ionosphere, Troposphere](#); USA; 2016.²¹
 - Risk phrases: “May cause harm to the unborn child. Also very toxic by inhalation. Also toxic: danger of serious damage to health by prolonged exposure through Inhalation.”
 - Additional toxicological information: “Avoid exposure of mercury to pregnant person.”

U.S. Regulations--U.S. Food and Drug Administration (FDA):

In [September of 2006](#), a joint panel of FDA scientific experts rejected an FDA White Paper’s assurances of the safety of dental mercury amalgam.²²

On July 28, 2008, the IAOMT submitted [a public comment to FDA](#)²³ demanding dental mercury amalgam be classified in conformance with the mandate of the [Medical Device Amendments of 1976](#).²⁴ Nearly a year later, the IAOMT also filed a Citizen’s Petition to further influence FDA policy-making on amalgam. A few days after that, on July 28, 2009, [FDA announced](#) it was classifying dental mercury amalgam for the first time in Class II without requiring any significant special controls.²⁵

FDA’s [Final Rule](#) on this issue was published on August 4, 2009,²⁶ and an FDA [warning](#) for dental mercury amalgam use in developing children and pregnant women (fetuses)²⁷ was soon removed from the FDA website. FDA also published an [Addendum](#) in support of its Final Rule,²⁸ which attempted to address the recommendations of the joint panels that convened in [September of 2006](#) when they rejected the proclamations of dental mercury amalgam safety set forth in the FDA’s White Paper on amalgam fillings.²⁹

Following the issuance of the FDA's Final Rule, the IAOMT sponsored a [Petition for Reconsideration](#) in 2009 which identified over 25 errors committed by FDA in its discussion of risk assessment principles.³⁰ Based on the IAOMT petition, the FDA scheduled a meeting of the Dental Products Panel of the Medical Devices Advisory Committee in December 2010. At the meeting, Dr. Suresh Kotagal, a pediatric neurologist at the Mayo Clinic announced: "...I think that there is really no place for mercury in children."³¹ The [2010 Dental Products Panel](#) encouraged the FDA to consider limiting dental mercury amalgam use in pregnant women and children and to consider labeling that would warn consumers about the risks of this mercury-containing product.³²

No formidable action was taken, and the IAOMT filed a lawsuit in 2014 against the FDA over its classification of dental mercury amalgam.³³ As part of the case, the IAOMT secured an [internal document from the FDA](#) that had proposed restricting dental mercury amalgam use in pregnant and nursing women and children under the age of six, as well as individuals with mercury allergies and pre-existing kidney or neurological disease.³⁴ Yet, allegedly for administrative reasons, the FDA communication (dated January 2012) was not released to the public.

On November 13-14, 2019, dental amalgam and metal implants were discussed at a meeting of the FDA's Immunological Device Panel³⁵ that was preceded by the release of [a literature review on mercury from dental amalgam](#)³⁶ and a report on [biological responses to metal implants](#).³⁷ IAOMT actively provided comments on the documents [in writing](#) and [in person at the event](#).

On September 24, 2020, the FDA issued [recommendations for dental amalgam](#) that warned "harmful health effects of mercury vapor released from the device" could impact high-risk populations.³⁸ **In particular, the following groups are now advised by the FDA to avoid getting dental amalgam whenever possible and appropriate: pregnant women and their developing fetuses; women who are planning to become pregnant; nursing women and their newborns and infants; children, especially those younger than six years of age; people with pre-existing neurological disease such as multiple sclerosis, Alzheimer's disease or Parkinson's disease; people with impaired kidney function; and people with known heightened sensitivity (allergy) to mercury or other components of dental amalgam.**³⁹

IAOMT's Position on Regulations:

Founded in 1984, [the International Academy of Oral Medicine and Toxicology \(IAOMT\)](#) is a worldwide organization of dentists, physicians, and research professionals devoted to the examination, compilation, and dissemination of scientific information about the biocompatibility of oral/dental materials. The fundamental mission of the IAOMT is to promote the health of the public. In this regard, the IAOMT continually reviews, composes, and shares analytical research and educational materials related to the biocompatibility of oral/dental materials.

Thus, this position paper was formulated by conducting a PubMed literature search, hand-searching an IAOMT collection of published literature, analyzing the available scientific data, reviewing personal experiences of IAOMT members in clinical settings, synthesizing expert opinions, funding relevant research to explore various aspects of dental mercury amalgam and non-amalgam alternate dental materials, and evaluating information about the issue provided by governmental authorities, health organizations, and environmental groups from around the world.

Additionally, this position paper clearly outlines significant quantities of reputable research and challenges the safety of dental mercury amalgam fillings by applying two cornerstones of public health policy: 1) risk assessment and 2) the precautionary principle.

1) “[Risk assessment](#)” has been defined by the FDA as follows: “Risk assessment consists of identifying and characterizing the nature, frequency, and severity of the risks associated with the use of a product. Risk assessment occurs throughout a product’s lifecycle, from the early identification of a potential product, through the premarketing development process, and after approval during marketing. Premarketing risk assessment represents the first step in this process prior to marketing.”⁴⁰

Risk assessment expert Dr. G. Mark Richardson was invited by the FDA to present the results of a major risk assessment analysis of dental mercury amalgam fillings at the [2010 FDA Dental Products Panel meeting](#).⁴¹ Dr. Richardson’s work, which established that millions of Americans exceed the intake of mercury vapor considered “safe” by the U.S. Environmental Protection Agency (EPA) due to the presence of dental mercury amalgam fillings, was published shortly thereafter.⁴² [FDA’s report about the 2010 meeting](#) noted: “The Panel deliberated on the exposure to mercury from dental amalgam, reference exposure levels, human clinical studies and the strength and weaknesses of the available evidence.”⁴³

Additionally, a conscientious and ethical deliberation of the data and analysis should include a second cornerstone of public health policy known as the precautionary principle.

2) In June 1992, the United Nations Environment Programme ratified the [Rio Declaration on Environment and Development](#) which, among other principles, established the precautionary approach among UNEP member states. In particular, Principle 15 states: “In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”⁴⁴

Further to the Rio Declaration, in January 1998, at an international conference involving scientists, lawyers, policy makers, and environmentalists from the United States, Canada and Europe, a formalized statement was signed and became known as the “[Wingspread Statement on the Precautionary Principle](#).”⁴⁵

In it, the following advice is given: “When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof.”⁴⁶

Based on scientific evidence, concepts of risk assessment, and the precautionary principle, it is our position that dental mercury amalgam fillings should not be used in dentistry. It should also be noted here that the IAOMT is concerned that dental mercury amalgam fillings are following the same delayed route to safety regulations as occurred with cigarettes and lead-based paint.

SUGGESTED ACTION BY MEDICAL AND DENTAL PRACTITIONERS AND PATIENTS:

INTERVENTIONS

Summary of Interventions:

- 1) The main ingredient for mercury amalgam fillings is mercury, approximately 50% by weight. Therefore, the appropriate terminology is “dental mercury amalgam fillings.”
- 2) Dental mercury amalgam fillings should not be used in dentistry.
- 3) The detrimental impact of mercury on fetuses, pregnant women, women of childbearing age, children, patients experiencing health issues, and dental workers mandate that special protection be provided to these populations with regards to dental mercury amalgam fillings.
- 4) Removal of existing dental mercury amalgam fillings requires safety measures for dentists, dental staff, dental students, and patients.

Detail of Interventions:

1) The main ingredient for mercury amalgam fillings is mercury, approximately 50% by weight. Therefore, the appropriate terminology is “dental mercury amalgam fillings.”

All dental amalgam restorations contain approximately 50% mercury,⁴⁷ and reports and research are consistent that these fillings emit mercury vapors.^{48 49 50 51 52 53 54 55 56 57 58 59 60 61 62}

Thus, while these restorations are commonly referred to as “silver fillings,” “dental amalgam,” and/or “amalgam fillings,” the public is often unaware that amalgam refers to the combination of other metals with mercury.⁶³ A 2014 Zogby poll established that 57% of Americans did not know that mercury is the main ingredient in amalgam fillings and that 63% thought the commonplace practice of referring to mercury amalgams as “silver fillings” was misleading.⁶⁴ It would be more appropriate therefore to recognize them as “dental mercury amalgam fillings,” “mercury silver fillings,” or “mercury fillings.” Terminology recognizing the main ingredient of mercury is needed so that medical and dental practitioners, dental students, patients, and policy makers are aware that mercury is the main ingredient in this medical device.^{65 66 67} As such, this document refers to these tooth restorations as “dental mercury amalgam fillings.”

Additionally, an understanding of the terminology associated with dentists that aim to end the use of dental mercury amalgam fillings is helpful to medical professionals and patients. These terms are commonly used, and dentists often choose one or several of these terms to describe their practice:

- “Mercury-free” is a term with a wide-range of implications, but it typically refers to dental practices that do not place dental mercury amalgam fillings.
- “Mercury-safe” typically refers to dental practices that use safety measures to limit or prevent mercury exposure, such as in the case of removing previously existing dental mercury amalgam fillings and replacing them with non-mercury alternatives.
- “Biological” or “Biocompatible” dentistry typically refers to dental practices that utilize mercury-free and mercury-safe dentistry while also considering the impact of dental conditions, devices, and treatments on oral and systemic health, including the biocompatibility of dental materials and techniques.

2) *Dental mercury amalgam fillings should not be used in dentistry.*

Exposure to mercury, even in minute amounts, is known to be toxic and poses significant risks to human health. A 2005 [World Health Organization report](#) warned of mercury: “It may cause harmful effects to the nervous, digestive, respiratory, immune systems and to the kidneys, besides causing lung damage. Adverse health effects from mercury exposure can be: tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during fetal development, and attention deficit and developmental delays during childhood. Recent studies suggest that mercury may have no threshold below which some adverse effects do not occur.”⁶⁸

Scientific research demonstrates that dental mercury amalgam exposes dental professionals, dental staff, dental patients, and fetuses to releases of mercury vapor, mercury-containing particulate, and/or other forms of mercury contamination.^{69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113} Dental mercury amalgam is therefore not a suitable material for dental restorations.

Furthermore, mercury vapor is known to be released from dental mercury amalgam fillings at higher rates during brushing, cleaning, clenching of teeth, chewing, etc.,^{114 115 116 117 118 119 120 121 122 123 124 125 126 127} and mercury is also known to be released during the placement, replacement, and removal of dental mercury amalgam fillings.^{128 129 130 131 132 133 134 135 136 137 138 139 140 141 142}

A series of studies demonstrate that urinary mercury concentrations consistently increase as the number of amalgam fillings increases.^{143 144 145 146 147 148} In these studies, the average urine mercury content is consistently greater in groups with amalgam fillings than in those without, and urine mercury content consistently increases as the number of dental mercury amalgam fillings increases.

Numerous studies have also demonstrated that the mercury exposure or concentration increases in the following tissues and situations

- Due to chewing, brushing, and/or bruxism^{149 150 151 152 153 154 155 156 157 158 159}
- In exhaled or intra-oral air of persons with amalgam fillings^{160 161 162 163}
- In saliva of persons with amalgam fillings^{164 165 166 167 168 169}
- In blood of persons with amalgam fillings^{170 171 172 173 174 175 176 177 178 179 180 181 182}
- In various organs and tissues of amalgam bearers, including the kidney, liver, pituitary gland, thyroid, and brain or parts thereof^{183 184 185 186 187}
- In feces of amalgam bearers^{188 189 190}
- In amniotic fluid, cord blood, placenta, and various fetal tissues including liver, kidney, brain, and hair in association with maternal amalgam load^{191 192 193 194 195 196 197 198 199}
- In colostrum and breast milk in association with maternal amalgam load^{200 201 202}

Scientific evidence confirms that in most individuals with dental mercury amalgam fillings, [mercury exposure exceeds the Reference Exposure Level \(REL\)](#).²⁰³ [REL is a term used to denote the exposure level defined by national and international regulatory agencies at which there is an expectation of *no negative health outcomes* within the population.]

Also, [reports from the World Health Organization \(WHO\)](#) and [Canada’s federal department of health \(Health Canada\)](#) conclude that mercury vapor from dental amalgam is the greatest source of human exposure to mercury in non-industrial settings.^{204 205}

Additionally, [in research published in 2011](#), Dr. G. Mark Richardson reported that more than 67 million Americans aged two years and older exceed the intake of mercury vapor considered “safe” by the U.S. EPA due to the presence of dental mercury amalgam fillings, whereas over 122 million Americans exceed the intake of mercury vapor considered “safe” by the California EPA due to their dental mercury amalgam fillings.²⁰⁶

3) The detrimental impact of mercury on fetuses, pregnant women, women of childbearing age, children, patients experiencing health issues, and dental workers mandate that special protection be given to these populations with regards to dental mercury amalgam fillings.

Mercury’s damaging influence on the developing brain and neurological system makes dental mercury amalgam fillings an inappropriate material for use in children, pregnant women, and women of childbearing age. In fact, research has repeatedly shown the potential for significant impacts to pregnant women, fetuses, and children as a result of dental mercury.^{207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246}

Additionally, physicians and dentists should, where patients are suffering from pathological states and/or disease of unclear causation, consider in their differential diagnosis whether exposure to mercury released from dental mercury amalgam fillings might be a contributing or exacerbating factor in such adverse health conditions. This is because dental mercury amalgam has been associated with a wide-range of adverse health conditions.^{247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343} It should also be remembered that reactions to mercury exposures vary from person to person, including exposures to dental mercury.^{344 345}

Finally, dentists, dental staff, and dental students are exposed to mercury at a greater rate than their patients. Severe exposures from past practices include hand-squeezing of fresh amalgam, where drops of liquid mercury could run over the dentist’s hands and contaminate the entire office.³⁴⁶ Dangerous levels of mercury are still generated in the dental workplace, and research has clearly identified that exposure to these mercury levels can cause ill-health to dental workers,^{347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382} and dental students.^{383 384 385} Another area that has received attention is the possibility of reproductive hazards to female dental personnel, including menstrual cycle disorders, fertility issues, and pregnancy risks.^{386 387 388 389 390 391 392 393}

Dental workers require protection from mercury exposures when working with dental mercury amalgam, and a variety of studies have specifically called for protective measures to be taken in the dental office as a means of limiting mercury releases.^{394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414}

4) *Removing dental mercury amalgam fillings requires safety measures for dentists, dental staff, and patients.*

Chronic (low dose, long-term) exposure to mercury for dentists, dental staff, dental students, and dental patients does not exist when alternative materials are used for dental fillings. However, there is a high risk of acute (high dose, short-term) mercury exposure to dentists, dental staff, dental students, and dental patients when dental mercury amalgam fillings are drilled out. Essentially, an unsafe amalgam removal process releases mercury vapor and particles that can be harmful to the patient, the dentist, the dental staff, and the environment.^{415 416 417 418 419 420 421 422}
^{423 424} Obviously, the danger to the patient is increased since mercury is being released directly into the mouth and lungs.

There are levels of increasing protection for limiting exposure during mercury-related dental procedures. Depending on the level of protection, health risks will vary. The challenge is training dentists from around the globe to use effective engineering controls and personal protective equipment as they remove the thousands of tons of mercury currently stored in the mouths of patients with dental mercury amalgam fillings. An additional challenge is training U.S. dentists to properly comply with both the current OSHA standards⁴²⁵ and the EPA standards.⁴²⁶

Utilizing the most up-to-date science and research, the IAOMT has developed extensive safety recommendations for removal of existing dental mercury amalgam fillings, including detailed protective measures that are to be utilized for the procedure.⁴²⁷ The IAOMT's innovative recommendations build upon traditional safe amalgam removal techniques such as the use of masks, water irrigation, and high volume suction by supplementing these conventional strategies with a number of additional protective measures, the need for which have only recently been identified in scientific research. The IAOMT's Safe Mercury Amalgam Removal Technique (SMART) is described in more detail on pages 14-16 below.

OUTCOMES CONSIDERED

Individual Response:

First, it should be noted that mercury influences each individual differently based on a wide-range of co-existing factors.⁴²⁸ For example, other health conditions (specified throughout this document), the number of amalgam fillings in the mouth^{429 430 431 432 433 434 435 436 437} and/or the number of amalgam surfaces in the mouth,^{438 439 440 441 442 443 444 445 446 447 448 449} the type of the amalgam filling (i.e. specific content of metals);^{450 451} gender;^{452 453 454 455 456 457 458} genetic predisposition;^{459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478} dental plaque;⁴⁷⁹ exposure to electromagnetic fields (EMF) from magnetic resonance imaging (MRI),^{480 481 482 483} mobile/cellular phones,⁴⁸⁴ and Wi-Fi;^{485 486 487} exposure to aluminum,^{488 489} fluoride,^{490 491} lead,^{492 493 494 495 496} and other environmental toxicants;⁴⁹⁷ selenium levels;^{498 499} consumption of milk^{500 501} or alcohol;⁵⁰² methylmercury levels from fish consumption;^{503 504 505} the potential for mercury from dental amalgam fillings to be transformed into methylmercury within the human body,^{506 507 508 509 510 511} and other circumstances^{512 513} can play a role in each person's unique response to mercury. Table 1 below shows a number of factors related to mercury responses.

TABLE 1: Abbreviated list of variables potentially influencing individual reactions to dental mercury exposure

| Factors related to mercury vapor release from dental amalgam filling |
|---|
| Age of amalgam filling |
| Cleaning, polishing, and other dental procedures |
| Contents of other materials mixed with the mercury, such as tin, copper, silver, etc. |
| Dental plaque |
| Deterioration of amalgam filling |
| Habits such as brushing, bruxism, chewing (including gum chewing, especially nicotine gum), consumption of hot liquids, diet (especially acidic foods), smoking, etc. |
| Infections in the mouth |
| Number of amalgam fillings |
| Other metals in the mouth, such as gold fillings or titanium implants |
| Root canals and other dental work |
| Saliva content |
| Size of amalgam filling |
| Surface area of amalgam filling |
| Techniques and safety measures applied when removing amalgam filling |
| Techniques used when placing amalgam filling |
| Exposure to electromagnetic fields (EMF) from magnetic resonance imaging (MRI), mobile/cellular phones, and Wi-Fi |
| Personal traits and conditions related to mercury exposure response |
| Alcohol consumption |
| Allergy or hypersensitivity to mercury |
| Bacteria, including mercury resistant and antibiotic resistant |
| Burdens in organs and tissues such as the kidney, pituitary gland, liver, and brain |
| Diet and levels of nutrients such as selenium |
| Drug use (prescription, recreational, and addiction) |
| Exercise |
| Exposure to other forms of mercury (i.e., fish consumption), aluminum, fluoride, lead, pollution, and any toxic substances (presently or previously) |
| Fetal or breast milk exposure to mercury, lead, and any toxic substances |
| Gender |
| Genetic traits and variants |
| Infections |
| Microbes in the gastrointestinal tract |
| Milk consumption |
| Nutrient levels, especially copper, zinc, and selenium |
| Occupational exposures to toxic substances |
| Overall health |
| Parasites and helminths |
| Stress/trauma |
| Yeast |

SOURCE: This has been adapted from Table 7.3 in Kall J, Just A, Aschner M. What is the risk? Dental amalgam, mercury exposure, and human health risks throughout the lifespan. *Epigenetics, the Environment, and Children's Health across Lifespans*. David J. Hollar, ed. Springer. 2016. pp. 159-206 (Chapter 7). Abstract available from: http://link.springer.com/chapter/10.1007/978-3-319-25325-1_7. Accessed March 19, 2019.

In the same way that individual response influences reactions to mercury exposures, individual response also varies from patient to patient upon amalgam removal. Research supports the fact that many patients benefit from having their amalgams removed and replaced with an alternative material. A few examples of conditions reportedly improved and/or cured as a result of removing dental metal allergens include amyotrophic lateral sclerosis,^{514 515} autoimmune thyroiditis,^{516 517 518 519 520} myalgic encephalomyelitis/chronic fatigue syndrome,^{521 522 523 524 525 526} dermatitis,^{527 528 529 530} fibromyalgia,^{531 532 533} multiple sclerosis,^{534 535 536} oral lichen planus,^{537 538 539 540 541 542 543} oral lichenoid lesion,^{544 545 546 547 548 549 550 551 552 553 554 555 556} orofacial granulomatosis,^{557 558} and other symptoms.^{559 560 561 562 563} In addition to the recovery situations mentioned above, which are specifically related to dental allergies, research has likewise documented the reduction of other health issues after the removal of mercury amalgam fillings.^{564 565 566 567 568 569 570 571 572 573 574 575 576 577 578} Table 2 is brief overview of some of the research articles showing improvement in autoimmune illnesses after amalgam removal.

TABLE 2: Condensed List of Research Documenting Improvement in Autoimmune Conditions upon Metal Implant/Device Removal, including Dental Mercury Amalgam Fillings

| Health Condition/s Improved or Recovered | Implant/Device Removed |
|--|---|
| Autoimmune Thyroiditis/ Fatigue | Dental mercury amalgam fillings ^{579 580 581 582} |
| Chronic Fatigue Syndrome (Myalgic Encephalomyelitis/Chronic Fatigue Syndrome) | Dental mercury amalgam fillings and other metallic dental restorations ^{583 584 585 586 587} |
| Chronic Fatigue Syndrome (Myalgic Encephalomyelitis/Chronic Fatigue Syndrome) | Nickel clips from tubal ligation, dental mercury amalgam fillings and other metallic dental restorations ⁵⁸⁸ |
| Crohn's Disease | Dental mercury amalgam fillings and other metallic dental restorations ⁵⁸⁹ |
| Dermatitis | Cobalt-chromium prosthesis and dental mercury amalgam fillings ⁵⁹⁰ |
| Fibromyalgia | Dental mercury amalgam fillings and other metallic dental restorations ^{591 592 593} |
| Multiple Sclerosis | Dental mercury amalgam fillings and other metallic dental restorations ^{594 595} |
| Multiple symptoms including fatigue, pain, depression, and headache | Dental mercury amalgam fillings and other metallic dental restorations ⁵⁹⁶ |
| Oral lichen planus | Dental mercury amalgam fillings and other metallic dental restorations ^{597 598} |
| Sjögren's Syndrome | Dental mercury amalgam fillings and other metallic dental restorations ^{599 600} |
| Systemic Lupus Erythematosus | Dental mercury amalgam fillings ⁶⁰¹ |

Amalgam Removal:

However, an outcome of dental mercury amalgam removal is acute exposure to mercury vapor and particulate for dentists, dental staff, dental students, and dental patients,^{602 603 604 605 606 607 608 609 610 611 612 613} especially endangering pregnant women, lactating women, women of childbearing age, fetuses, children, and other sensitive populations.

Other than primary exposures during dental mercury amalgam removal, secondary exposures in less obvious areas of the dental office are emerging as additional sources of chronic mercury exposures. Some of these peripheral exposures include the following:

- mercury exposure to staff, patients, and visitors in other parts of the office not directly involved in the removal process
- environmental mercury exposure caused by the waste from removal and storage of amalgam, especially because the ADA's "[Best Management Practices for Amalgam Waste](#)"⁶¹⁴ is voluntary
- storage and disposal of workplace protective clothing and instruments used during procedures involving dental mercury amalgam
- mercury vapor exposure from sterilization of instruments used on dental mercury amalgam fillings
- mercury vapor and particulate on the carpeting/flooring, walls, ceilings, drapes, HVAC ducts, etc.
- mercury particulate that is carried home in hair, on shoes, clothing, and other items from the dental office

To assist in mitigating the potential negative outcomes of both primary and secondary mercury exposure during amalgam removal, the IAOMT has developed new safety recommendations for removal of existing dental mercury amalgam fillings to protect dental professionals, students, staff members, patients, and others from mercury exposure.⁶¹⁵

More specifically, the IAOMT's [Safe Mercury Amalgam Removal Technique \(SMART\)](#) includes the following practices, which are cited here with scientific research supporting each step of the technique:

An amalgam separator must be properly installed, utilized, and maintained to collect mercury amalgam waste so that it is not released into the effluent from the dental office.^{616 617 618 619 620 621 622 623 624 625 626 627 628 629}

Each room where mercury fillings are removed must have adequate filtration in place,^{630 631 632 633} which requires a high-volume air filtration system (such as an at source oral aerosol vacuum) capable of removing mercury vapor and amalgam particles generated during the removal of one or more mercury fillings.^{634 635}

If possible, windows should be opened to reduce the mercury concentration in the air.^{636 637 638 639}

The patient will be given a slurry of charcoal, chlorella, or similar adsorbent to rinse and swallow before the procedure (unless the patient declines or there are other contraindications making this clinically inappropriate).^{640 641 642}

Protective gowns and covers for the dentist,^{643 644} dental personnel,^{645 646} and the patient⁶⁴⁷ must be in place. All present in the room must be protected because substantial quantities of particles generated during the procedure will elude collection by suction devices.^{648 649} It has been demonstrated that these particles can be spread from the patient's mouth to the hands, arms, face, chest and other parts of the dental worker's and patient's anatomy.⁶⁵⁰

Non-latex nitrile gloves must be utilized by the dentist and all dental personnel in the room.^{651 652 653 654 655}

Face shields and hair/head coverings are to be utilized by the dentist and all dental personnel in the room.^{656 657 658}

Either a properly-sealed, respiratory grade mask rated to capture mercury or a positive pressure, properly-sealed mask providing air or oxygen must be worn by the dentist and all dental personnel in the room.^{659 660 661 662}

In order to protect the patient's skin and clothing, a full body, impermeable barrier, as well as a full head/face/neck barrier under/around the dam, need to be utilized.^{663 664 665}

External air or oxygen delivered via a nasal mask for the patient also needs to be utilized to assure the patient does not inhale any mercury vapor or amalgam particulate during the procedure.^{666 667 668} A nasal cannula is an acceptable alternative for this purpose as long as the patient's nose is completely covered with an impermeable barrier.

A dental dam^{669 670 671 672 673 674 675} that is made with non-latex nitrile material^{676 677 678} must be placed and properly sealed in the patient's mouth.

A saliva ejector must be placed under the dental dam to reduce mercury exposure to the patient.^{679 680}

During amalgam filling removal, the dentist must utilize an at source oral aerosol vacuum in close proximity to the operating field (i.e., two to four inches from the patient's mouth) to mitigate mercury exposure.^{681 682}

High speed evacuation produces better capture when fitted with a Clean Up device,^{683 684} which is not mandatory but is preferred.

Copious amounts of water to reduce heat^{685 686 687 688 689 690 691 692} and a conventional high speed evacuation device to capture mercury discharges^{693 694 695 696 697 698 699 700 701 702} are required to reduce ambient mercury levels.⁷⁰³

The amalgam needs to be sectioned into chunks and removed in as large of pieces as possible,^{704 705 706 707} using a small diameter carbide drill.^{708 709}

Once the removal process is complete, the patient's mouth should be thoroughly flushed with water^{710 711} and then rinsed out with a slurry of charcoal, chlorella or similar adsorbent.⁷¹²

Dentists must comply with federal, state, and local regulations addressing the proper handling, cleaning, and/or disposal of mercury-contaminated components, clothing, equipment, surfaces of the room, and flooring in the dental office.

During the opening and maintenance of suction traps in operatories or on the main suction unit, dental staff should utilize the appropriate personal protection equipment described above.

In addition to the research cited above supporting each step of the IAOMT's SMART protocol, SMART has also been recommended by [researchers of a study published in 2019 in the peer-reviewed *Journal of Pharmacy and Bioallied Sciences*](#).⁷¹³

Alternatives to Amalgams:

Obviously, once amalgams have been removed, they must be replaced with a different dental filling material. Alternatives to amalgam include composite resin, glass ionomer, porcelain, and gold, among other options. When given the choice, most consumers opt for direct composite fillings because the white coloring matches the tooth better and the cost is considered moderate.

In the past, a common argument against composite fillings was that they were not as durable as amalgam. However, recent studies have debunked this claim. Researchers of a study which was published in 2016 and conducted on over 76,000 patients for over ten years found that posterior amalgam fillings had a *higher* annual failure rate than composites.⁷¹⁴ Two separate studies published in 2013 found that composite fillings performed as well as amalgam when comparing failure rates⁷¹⁵ and replacement filling rates.⁷¹⁶ Other research has offered similar findings:

- a study about the longevity of composite fillings published in 2017 and authored by researchers at the University of Pittsburgh School of Dental Medicine concluded that composites can replace amalgam restorations;⁷¹⁷
- a study published in 2015 documented “good clinical performance” of composite resins over a 30-year evaluation;⁷¹⁸
- a meta-analysis published in 2014 noted “good survival” of posterior resin composite restorations;⁷¹⁹
- and a study published in 2011 found “good clinical performance” of composites over a 22-year period.⁷²⁰

Research has further confirmed that composite resins present a lower risk for chemical exposures. In a 2016 publication co-authored by risk assessment specialist Dr. G. Mark Richardson, it was reported: “Relative risks of chemical exposures from dental materials decrease in the following order: Amalgam>Au alloys>ceramics>composite resins.”⁷²¹

Yet, composite fillings have been criticized because some of them contain fluoride and/or bisphenol-A (BPA). Dentists have a variety of opinions about the safety of fluoride, BPA, and other types of bisphenol, such as Bis-GMA and Bis-DMA. Patients who are concerned about the specific components of their fillings often choose to speak with their dentists about using a material that does not contain certain ingredients. For example, a product named Admira Fusion⁷²²/Admira Fusion X-tra⁷²³ released in January 2016 by the dental company VOCO is being touted as “the first purely ceramic-based restorative material”⁷²⁴ and does not contain Bis-GMA or BPA before or after it has been cured.

Any replacement materials, including ceramics, composites, gold, and other types of metal, should be assessed for safety and biocompatibility with special consideration for all populations and all known risk factors.⁷²⁵ In particular, clinical screening for patients’ metal allergies has been recommended,⁷²⁶ and the importance of patients reporting reactions to metals to their doctors has been emphasized in the scientific literature.^{727 728 729 730 731 732} In addition to reporting any rashes from jewelry, watches, or other metal exposures, it is essential for each patient to recognize the gamut of symptoms that can be related to the presence of a metal implant or device in their body. It is also vital for patients to remember that sensitization to metal can develop years after an implant or device has been placed and that adverse effects can occur *with or without* the sign of a rash or eruption on the skin or in the mouth.

Allergy testing can be used to assist in identifying some of the individuals susceptible to adverse reactions to metals. Patch testing is generally regarded as the “gold standard” in allergy testing; however, patch testing has also been criticized because it involves directly applying the allergen to the skin, it can exacerbate symptoms in patients, it can result in sensitization, and the results can be affected by other conditions.⁷³³ Two relatively new alternatives to skin patch testing are a modified version of the Lymphocyte Transformation Test (LTT) known as [MELISA](#)⁷³⁴ and the Lymphocyte Response Assay (LRA) by [ELISA/ACT Biotechnologies](#).⁷³⁵

Another option for testing has been created specifically for dental materials. If this biological testing is used, a patient’s blood sample is sent to a laboratory where the serum is evaluated for the presence of IgG and IgM antibodies to the chemical ingredients used in dental products.⁷³⁶ The patient is then provided with a detailed list of which name-brand dental materials are safe for their use and which ones could result in a reaction. Two labs that currently offer this service are [Biocomp Laboratories](#)⁷³⁷ and [ELISA/ACT Biotechnologies](#).⁷³⁸

It is important to note that many factors can influence whether or not a patient improves after the removal of a metal implant or device. While many patients improve or even recover, there are some who do not. One obvious reason for this is if the patient is still being exposed to the metal or a different sensitizer through another implant, device, or other source. In a most unfortunate circumstance, patients can even have a reaction to the new implant or device. This is why it is crucial to select a biocompatible replacement.

Susceptible Populations:

In conclusion, the following populations could substantially reduce the risk of harm from mercury exposure by taking the suggested measures:

- 1) Minimization of exposure to dental mercury, vapor, and particulate for
 - All dental professionals, dental staff (including hygienists), and dental students who work with dental mercury amalgam
 - All patients with existing dental mercury amalgam fillings
 - All patients requiring the cleaning and/or removal of dental mercury amalgam fillings
- 2) Avoidance of dental mercury amalgam fillings for
 - All patients requiring new dental fillings
 - Pregnant or lactating women
 - Women of childbearing age
 - Fetuses
 - Children
 - Patients genetically predisposed to mercury toxicity
 - Patients with
 - Allergies, especially allergy to mercury
 - Alzheimer's disease
 - Amyotrophic lateral sclerosis (Lou Gehrig's disease)
 - Antibiotic resistance
 - Autism spectrum disorders
 - Autoimmune disorders/immunodeficiency
 - Cardiovascular problems
 - Chronic fatigue, fatigue, and/or myalgic encephalomyelitis/chronic fatigue syndrome
 - Complaints of unclear causation
 - Dermatitis
 - Fibromyalgia
 - Gastrointestinal issues and/or irritable bowel syndrome
 - Hearing loss
 - Kidney disease
 - Micromercurialism
 - Multiple sclerosis
 - Oral lichenoid reaction and oral lichen planus
 - Orofacial granulomatosis
 - Parkinson's disease
 - Periodontal disease
 - Psychological issues such as depression and anxiety
 - Reproductive dysfunction
 - Suicidal ideations
 - Symptoms of chronic mercury poisoning
 - Systemic lupus erythematosus
 - Thyroiditis
 - Patients undergoing chelation treatment or other detoxification treatments

MAJOR RECOMMENDATIONS

Recommendations:

- 1) Dental mercury amalgam fillings should not be used in dentistry.
- 2) Furthermore, safety precautions should be taken when working with and/or removing previously existing dental mercury amalgam fillings so as not to expose dentists, dental staff, dental students, dental patients, and their fetuses and breast-feeding children to mercury.
- 3) Moreover, based on scientific evidence, the practice of mercury-free dentistry [dentistry that does not place any new mercury amalgam fillings] and mercury-safe dentistry [dentistry that utilizes protective measures when removing existing mercury amalgam fillings] as a means of improving public health should especially be considered for the following reasons:

○ WORKPLACE EXPOSURE:

- Dentists, dental professionals, dental staff, and dental students are occupationally and chronically exposed to mercury released from dental mercury amalgam, and researchers and clinicians have raised concerns about the safety of dental personnel and students who work with dental mercury amalgam.^{739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791}
- This includes mercury released during hygiene, cleaning, and polishing procedures.
- This includes mercury released during removal of old mercury amalgam fillings and replacement with new ones.
- Scientific data indicates that female dental personnel are uniquely impacted by occupational exposure to mercury.^{792 793 794 795 796 797 798}

○ PATIENT EXPOSURE:

- Mercury vapor is continuously emitted from dental mercury amalgam fillings, and particulate can also be discharged from dental mercury amalgam fillings,^{799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824} which means that people are directly exposed to mercury as a result of their dental mercury amalgam fillings.
- The output of mercury is intensified by the number of amalgam fillings in the mouth^{825 826 827 828 829 830 831 832 833} and/or the number of amalgam surfaces in the mouth,^{834 835 836 837 838 839 840 841 842 843 844 845} the type of the amalgam filling (i.e. specific content of metals),^{846 847} and other factors such as chewing, teeth-grinding, brushing, dental treatments and procedures, and the consumption of hot liquids.^{848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867}
- This includes mercury released during hygiene, cleaning, and polishing procedures.
- This includes mercury released during placement of new restorations and removal of old ones.
- Ergo, men, women, and children patients are all at risk from the hazards of mercury released from dental mercury amalgam fillings.

○ GENETIC PREDISPOSITION:

- Mercury exposure from dental mercury amalgam particularly threatens individuals with genetic variants that can impact their response to mercury exposures such as those with CPOX4,^{868 869 870} APOE(3,4),^{871 872 873 874} and BDNF (brain-derived neurotropic factor) polymorphisms.^{875 876 877}
- Recent research has identified a genetic predisposition to neurological impacts by mercury exposure from dental amalgam in male children with the polymorphism CPOX4.^{878 879}
- Other than CPOX4, APOE, and BDNF polymorphisms, genetic traits that have been examined for association with health impairments caused by mercury exposure include metallothionein (MT) polymorphisms,^{880 881} catechol-O-methyltransferase (COMT) variants,⁸⁸² PON1 variants,^{883 884} MTHFR mutations and other genetic aspects.^{885 886 887}

○ WOMEN AND CHILDREN:

- Fetal and infant exposure to mercury is known to have potentially serious health consequences, and the number of maternal amalgam fillings has been associated with mercury levels in cord blood,^{888 889 890} in the placenta,⁸⁹¹ in the kidneys^{892 893} and liver⁸⁹⁴ of fetuses; in fetal hair;^{895 896} and in the brain⁸⁹⁷ and kidneys⁸⁹⁸ of infants; as well as the risk of perinatal death.⁸⁹⁹
- Mercury is excreted in breast milk of mothers with dental mercury amalgam fillings, and the mercury concentration in breast milk increases as the number of amalgam fillings in the mother increases.^{900 901 902 903}
- Additional research has likewise examined the potential dangers that dental amalgam mercury poses to pregnant women, their fetuses, and infants.^{904 905 906 907 908 909 910 911 912 913 914 915 916}
- Children are also at-risk for health impairments linked to dental amalgam mercury fillings.^{917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934}

○ ALLERGY TO MERCURY:

- This is a completely separate health issue from toxicity.
- Based on statistics from the North American Contact Dermatitis Group,⁹³⁵ it is estimated that approximately 21 million Americans are allergic to mercury. However, this figure could be even higher because recent studies and reports tend to agree that metal allergies are on the rise.^{936 937}
- Most patients are not tested for dental metal allergies, but, according to statistics in scientific research,^{938 939} millions of patients are allergic or sensitive to the dental mercury amalgam fillings in their mouths because of the mercury or the other components. In addition to research that demonstrates this is a pertinent issue,^{940 941 942 943 944 945 946} a number of patients with health conditions linked to dental metal allergies have improved or recovered from their ailments after removal of their fillings.^{947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980}
- Studies also establish that exposure to dental mercury amalgam fillings correlates with higher prevalence of mercury allergies.^{981 982}

○ ADDITIONAL AT-RISK POPULATIONS:

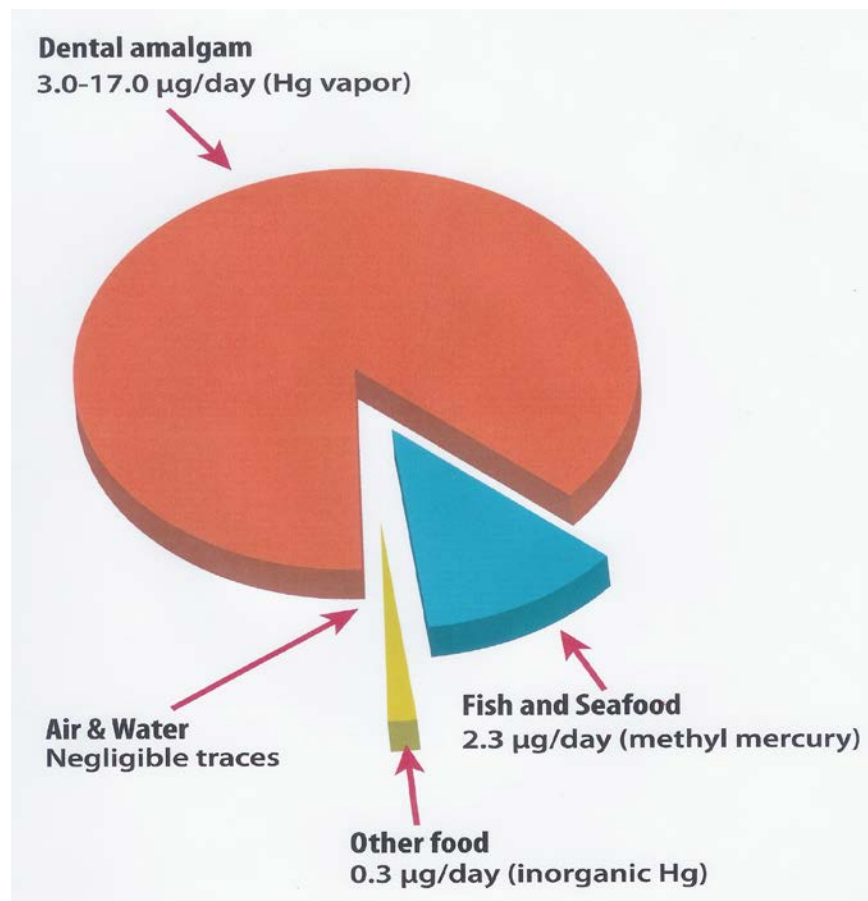
- Dental mercury amalgam fillings can potentially exacerbate and/or contribute to the conditions stated below, as well as a myriad of other health outcomes:
 - Patients with
 - Allergies^{983 984 985}
 - Alzheimer's disease^{986 987 988 989 990}
 - Amyotrophic lateral sclerosis (Lou Gehrig's disease)⁹⁹¹
 - Antibiotic resistance^{992 993 994 995}
 - Autism spectrum disorders^{996 997 998 999}
 - Autoimmune disorders/immunodeficiency^{1000 1001 1002 1003 1004 1005 1006 1007 1008}
 - Cardiovascular problems^{1009 1010 1011}
 - Chronic fatigue, fatigue, and/or myalgic encephalomyelitis/chronic fatigue syndrome^{1012 1013 1014 1015 1016 1017 1018 1019}
 - Complaints of unclear causation^{1020 1021 1022 1023 1024 1025 1026}
 - Dermatitis^{1027 1028}
 - Fibromyalgia^{1029 1030 1031 1032}
 - Gastrointestinal issues and/or irritable bowel syndrome^{1033 1034 1035}
 - Hearing loss¹⁰³⁶
 - Kidney disease^{1037 1038 1039 1040 1041 1042 1043 1044}
 - Micromercurialism¹⁰⁴⁵
 - Multiple sclerosis^{1046 1047 1048 1049}
 - Oral lichenoid reaction^{1050 1051 1052 1053 1054 1055 1056 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066} and oral lichen planus^{1067 1068 1069 1070 1071}
 - Orofacial granulomatosis^{1072 1073}
 - Parkinson's disease^{1074 1075 1076 1077 1078 1079 1080}
 - Periodontal disease^{1081 1082}
 - Psychological issues such as depression and anxiety^{1083 1084 1085 1086 1087 1088 1089}
 - Reproductive dysfunction^{1090 1091}
 - Suicidal ideations^{1092 1093}
 - Symptoms of chronic mercury poisoning¹⁰⁹⁴
 - Systemic lupus erythematosus¹⁰⁹⁵
 - Thyroiditis^{1096 1097 1098 1099 1100}
 - Patients undergoing chelation treatment or other detoxification treatments

Additional Data Supporting Recommendations:

The data on the following pages provide additional information about the hazards of dental mercury amalgam fillings and mercury exposure presented in these recommendations:

CHART 1: This chart shows that dental mercury amalgam is the major route of mercury exposure for the general public.

Sources of Human Mercury Exposure (World Health Organization [WHO], 1991)*



*Note: In 1991, the [WHO Environmental Health Criteria 118](#) concluded that “[e]stimated average daily intake and retention” from dental amalgam was **3.8-21 (3-17) ug/day**.¹¹⁰¹ In the [2003 Executive Summary](#) of this document, WHO stated: “Dental amalgam constitutes a potentially significant source of exposure to elemental mercury, with estimates of daily intake from amalgam restorations ranging from **1 to 27 ug/day**.”¹¹⁰² [Emphasis added]

TABLE 3: This is a list of common symptoms of elemental mercury vapor inhalation^{1103 1104 1105}
^{1106 1107 1108 1109 1110 1111 1112} to be considered by practitioners when evaluating the possible side effects of dental mercury amalgam:

| | | |
|--|--|--|
| Acrodynia or similar symptoms such as emotional instability, loss of appetite, general weakness, and skin changes (<i>Magos and Clarkson, 2006</i>) | Anorexia (<i>Bernhoft, 2011</i>) | Cardiovascular problems/ labile pulse [frequent changes in heart rate]/tachycardia [abnormally rapid heartbeat] (<i>Klassen, 2008</i>) |
| Cognitive/neurological impairments /memory loss/decrease in mental function/difficulties with verbal and visual processing (<i>Echeverria et al., 1998; Clarkson and Magos, 2006; Magos and Clarkson, 2006; Syversen and Kaur, 2012; USEPA, 2016</i>) | Delusions/delirium/hallucination (<i>Bernhoft, 2011; Syversen and Kaur, 2012</i>) | Dermatological conditions/ dermographism [skin condition characterized by raised red marks]/dermatitis (<i>Bernhoft, 2011; Klassen, 2008</i>) |
| Endocrine disruption /enlargement of thyroid (<i>Bernhoft, 2011; Klassen, 2008</i>) | Erethism [symptoms such as irritability, abnormal responses to stimulation, and emotional instability] (<i>Bernhoft, 2011; Clarkson et al., 2003; Clarkson and Magos, 2006; Magos and Clarkson, 2006</i>) | Fatigue (<i>Bernhoft, 2011; Echeverria et al., 1998</i>) |
| Headaches (<i>USEPA, 2016</i>) | Hearing loss (<i>Rothwell and Boyd, 2008</i>) | Immune system impairments (<i>Bernhoft, 2011; Clarkson and Magos, 2006</i>) |
| Insomnia (<i>USEPA, 2016</i>) | Nerve response changes /peripheral neuropathy/decreased coordination/ decreased motor function/ polyneuropathy/neuromuscular changes such as weakness, muscle atrophy, and twitching (<i>Bernhoft, 2012; Clarkson et al., 2003; Clarkson and Magos, 2006; Echeverria et al., 1998; USEPA, 2016</i>) | Oral manifestations/ gingivitis/metallic taste/oral lichenoid lesions/stomatitis/salivation (<i>Bernhoft, 2011; Camisa et al., 1999; Clarkson et al., 2003; Clarkson and Magos, 2006; Klassen, 2008; Magos and Clarkson, 2006</i>) |
| Psychological issues /mood changes related to anger, depression, excitability, irritability, mood swings, and nervousness (<i>Echeverria et al., 1998; Klassen, 2008; Magos and Clarkson, 2006; USEPA, 2016</i>) | Renal [kidney] problems/ proteinuria/nephrotic syndrome (<i>Bernhoft, 2011; Clarkson et al., 2003; Clarkson and Magos, 2006; Klassen, 2008; USEPA, 2016; Syversen and Kaur, 2012</i>) | Respiratory problems/ bronchial irritation/bronchitis/cough/ dyspnea [breathing difficulties]/ pneumonitis/respiratory failure (<i>Bernhoft, 2011; Clarkson et al., 2003; Echeverria et al., 1998; Klassen, 2008; Magos and Clarkson, 2006; Syversen and Kaur, 2012; USEPA, 2016</i>) |
| Shyness [excessive shyness]/social withdrawal (<i>Magos and Clarkson, 2006; USEPA, 2016</i>) | Tremors /mercurial tremors/intention tremors (<i>Bernhoft, 2011; Clarkson and Magos, 2006; Klassen, 2008; USEPA, 2016; Syversen and Kaur, 2012</i>) | Weight loss (<i>Bernhoft, 2011</i>) |

EVALUATION OF SUGGESTED ACTION:

POTENTIAL BENEFITS

By minimizing mercury exposure from dental mercury amalgam fillings or completely avoiding the use of dental mercury amalgam fillings, an individual's total body burden of mercury is beneficially reduced. Minimizing or eliminating mercury exposure can potentially result in improvement and/or decreased risk of disease/illness/health impairments for

All dental professionals, dental staff (including hygienists), and dental students who work with dental mercury amalgam

All patients with existing dental mercury amalgam fillings

All patients requiring the cleaning and/or replacement of dental mercury amalgam fillings

All patients requiring new dental fillings

Pregnant or lactating women

Women of childbearing age

Fetuses

Children

Patients genetically predisposed to mercury toxicity

Patients with

- Allergies, especially allergy to mercury
- Alzheimer's disease
- Amyotrophic lateral sclerosis (Lou Gehrig's disease)
- Antibiotic resistance
- Autism spectrum disorders
- Autoimmune disorders/immunodeficiency
- Cardiovascular problems
- Chronic fatigue, fatigue, and/or myalgic encephalomyelitis/chronic fatigue syndrome
- Complaints of unclear causation
- Dermatitis
- Fibromyalgia
- Gastrointestinal issues and/or irritable bowel syndrome
- Hearing loss
- Kidney disease
- Micromercurialism
- Multiple sclerosis
- Oral lichenoid reaction and oral lichen planus
- Orofacial granulomatosis
- Parkinson's disease
- Periodontal disease
- Psychological issues such as depression and anxiety
- Reproductive dysfunction
- Suicidal ideations
- Symptoms of chronic mercury poisoning
- Systemic lupus erythematosus
- Thyroiditis

Patients undergoing chelation treatment or other detoxification treatments

As far as considering the costs of implementing these recommendations, in a report entitled “The Economics of Dental Amalgam Regulation,” the authors noted that amalgam use is already declining and that restrictions on mercury are inevitable.¹¹¹³ The authors concluded, “We can then make the case that the overall health care expenditures necessary to deal with diseases and conditions, known or unknown, arising from the continued installation of amalgam could far exceed the relatively manageable cost increases to the consumer for the alternatives... This is not to mention the cost to the U.S. economy of lost work time owing to concomitant illness and disability.”¹¹¹⁴

Additionally, the IAOMT co-released a [2012 report from Concorde](#) of Brussels, Belgium, which noted: “In order to obtain a useful perspective on the ‘external’ costs to society that are not included in the fees a dental patient pays the practitioner, we have examined 1) the costs of keeping dental mercury releases from being released into the environment, and 2) when dental mercury is no longer released into the environment, the various benefits accrued to human health and society. ...[W]hichever analytical approach one chooses, even when using conservative assumptions, and even allowing for the uncertainties inherent in much of the cost data, it is clear that the real cost of using amalgam far outweighs the cost of using mercury-free composite...”¹¹¹⁵

Yet, from a consumer standpoint, some insurance companies only cover the cost of dental mercury amalgam fillings, which means that oftentimes patients have to pay additional fees for alternative materials and techniques.¹¹¹⁶ However, the United Nations Environmental Programme (UNEP)’s 2013 “Minamata Convention on Mercury,” signed by over 100 nations including the U.S., specifically discourages insurance policies and programs favoring dental mercury amalgam use over mercury-free dental restoration.¹¹¹⁷

Since some countries have successfully eliminated dental mercury amalgam, ending the use of mercury in dentistry has already proven to be both feasible and economical. For example, Carsten Lassen and Jakob Maag, of the Nordic Council of Ministers, shared the following observation with a committee of the United Nations in 2010: “Dental treatment without mercury is becoming the norm.”¹¹¹⁸ Norwegian dental researchers confirmed this statement in 2016 when they wrote: “Norwegian dentists showed positive attitudes towards composite as a restorative material one year after amalgam was banned.”¹¹¹⁹

Additionally, scientific research about the measurements of mercury in dental offices has been instrumental in helping policy-makers and dentists around the world take steps to adopt workplace standards that reduce mercury releases in the dental office. Researchers from the USA, Africa, Asia and the United Nations explained in their 2018 scientific review published in the peer-reviewed journal *Ambio*:

For example, a civil society-initiated campaign to phase down the use of Hg amalgams in Asia and Africa faced initial resistance from policy-makers and dentists who did not believe that Hg posed a risk... On-the-spot measurements demonstrating high Hg levels proved to be a strong and salient method of risk communication with dentists across different cultural settings, and helped garner support for changing workplace practices to reduce Hg exposure.¹¹²⁰

POTENTIAL HARMS

1) There is a risk of additional mercury exposure to dentists, dental staff, hygienists, dental students, and patients from current unsafe procedures involving mercury amalgam fillings, especially if treatment, hygiene routines, removal, and/or replacement of fillings are conducted without taking appropriate protective measures.

2) As such, special consideration of any dental work involving amalgam mercury fillings should be given to

All dental professionals, dental staff (including hygienists), and dental students who work with dental mercury amalgam

All patients with existing dental mercury amalgam fillings

All patients requiring the cleaning and/or removal of dental mercury amalgam fillings

All patients requiring new dental fillings

Pregnant or lactating women

Women of childbearing age

Fetuses

Children

Patients genetically predisposed to mercury toxicity

Patients with

- Allergies, especially allergy to mercury
- Alzheimer's disease
- Amyotrophic lateral sclerosis (Lou Gehrig's disease)
- Antibiotic resistance
- Autism spectrum disorders
- Autoimmune disorders/immunodeficiency
- Cardiovascular problems
- Chronic fatigue, fatigue, and/or myalgic encephalomyelitis/chronic fatigue syndrome
- Complaints of unclear causation
- Dermatitis
- Fibromyalgia
- Gastrointestinal issues and/or irritable bowel syndrome
- Hearing loss
- Kidney disease
- Micromercurialism
- Multiple sclerosis
- Oral lichenoid reaction and oral lichen planus
- Orofacial granulomatosis
- Parkinson's disease
- Periodontal disease
- Psychological issues such as depression and anxiety
- Reproductive dysfunction
- Suicidal ideations
- Symptoms of chronic mercury poisoning
- Systemic lupus erythematosus
- Thyroiditis

Patients undergoing chelation treatment or other detoxification treatments

3) Alternative dental restorative materials should likewise be assessed for safety and biocompatibility, especially on an individual basis.

4) Some insurance companies only cover the cost of dental mercury amalgam fillings which means that oftentimes consumers have to pay additional fees for alternative materials and techniques.¹¹²¹

Furthermore, whereas amalgams are used for 45% of all direct dental restorations worldwide,¹¹²² articles published in the *Journal of the American Dental Association* have established that these mercury fillings are used on 51.0% of White/Caucasian Americans, on 53.4% of Black/African Americans, on 72.9% of American Indians/Alaska Natives/Asians/Pacific Islanders,¹¹²³ and on more than 75% of posterior restorations for new recruits to the U.S. Navy and Marines.¹¹²⁴

However, the United Nations Environmental Programme's 2013 "Minamata Convention on Mercury," signed by over 100 nations including the United States, specifically discourages insurance policies and programs favoring dental mercury amalgam use over mercury-free dental restoration.¹¹²⁵

CONTRAINDICATIONS

1) Dentists, dental staff, and dental students working with mercury amalgam fillings during procedures such as cleaning, hygiene, and/or replacement are significantly exposed, along with their patients, fetuses, and breast-feeding children to mercury. Safety measures, when used, diminish but do not totally eliminate exposure.

2) Removal of dental mercury amalgam fillings without appropriate protection causes significant mercury exposure to dentists, dental staff, dental students, and patients, especially women of childbearing age, pregnant or lactating women, fetuses, children, and other sensitive populations.

3) Due to mercury releases, polishing, placement, removal, or any disruption of a dental mercury amalgam filling should not be done by dental personnel who are pregnant or lactating and should not be conducted upon patients who are pregnant or lactating.

4) Alternative dental restorative materials should likewise be assessed for safety and biocompatibility, especially on an individual basis.

QUALIFYING STATEMENTS

Although the use of dental mercury amalgam fillings has reportedly been decreasing in developing countries,¹¹²⁶ the results of a survey published in 2017 in the *Journal of Public Health Dentistry* suggested that 62% of general dentists and 56% of pediatric dentists in the U.S. were still using dental mercury amalgam.¹¹²⁷ Additionally, billions of people have dental amalgam fillings in their mouths,¹¹²⁸ which means that even when the use of dental mercury ends, safe removal of amalgam fillings will continue to be a pertinent issue.

Whereas the American Dental Association (ADA), the United States Food and Drug Administration (FDA), and other groups have endorsed the use of dental mercury amalgam, numerous peer-reviewed, scientific studies report risks associated with dental mercury amalgam fillings. In fact, over 350 articles produced by a literature search on PubMed (collected by the U.S. National Library of Medicine National Institutes of Health) and a hand-search of IAOMT documents (collected by the International Academy of Oral Medicine and Toxicology) have been cited as evidence for this document.

The PubMed literature search was conducted online at the [PubMed database](#) from September 16, 2013 to March 6, 2014. The purpose of the research was to answer the following question: “Are there risks associated with dental mercury?” The PubMed search term used was “dental mercury risk,” and clinical trials and reviews were included in the search. The search was conducted from March 6, 2014 to as far back as PubMed provided results (1972), and the PubMed search resulted in 280 sources.

All PubMed sources were categorized into risk, no risk, or ambiguous categories. Articles were excluded from the final results of the search if they were not in English, they were not relevant (i.e. not significantly about dental mercury amalgam), they were an erratum, they were a comment on a different article, and/or if the abstract and study could not be found. Thus, 124 articles were excluded. Many of the articles that could not be located were not peer-reviewed and appeared in trade journals or journals of localized dental groups. Based on the 156 articles that were included, the PubMed search yielded 86 articles (55.1%) suggesting risk, 55 articles (35.3%) suggesting no risk, and 15 articles (9.6%) deemed as ambiguous.

An IAOMT hand-search of documents was conducted to supplement the PubMed search. The hand-search was originally conducted from September 16, 2013 to March 6, 2014, but it was first updated from December 1, 2015 to December 23, 2015, and then updated again from May 1, 2018 to March 20, 2019. Over 1,200 documents about this issue are currently on file in the IAOMT’s Library, which has documents dating from 1926 to present day. Of these hundreds of sources, those used for this article were limited to the scientific and regulatory documents most relevant to dental mercury amalgam health risks.

Even more specifically, sources for this paper were found by searching the IAOMT Library for scientific evidence of health risks from dental mercury exposures to the general population, pregnant women, fetuses, children, dental professionals, and those individuals who are genetically predisposed, who have an allergy to mercury, or who suffer from health conditions that have been potentially linked to mercury by scientific research. These health conditions include Alzheimer’s disease, amyotrophic lateral sclerosis (Lou Gehrig’s disease), antibiotic resistance, autism spectrum disorders, autoimmune disorders/immunodeficiency, cardiovascular problems, chronic fatigue syndrome, hearing loss, kidney disease, multiple sclerosis, oral lichenoid reaction and oral lichen planus, Parkinson’s disease, periodontal disease, and reproductive dysfunction.

The over 350 articles from the PubMed and IAOMT searches demonstrating risk have been used as sources for this document since they serve as evidence of the known hazards of dental mercury amalgam.

However, it should be noted that there were also a number of scientific studies suggesting dental amalgam does not pose a health risk, dental amalgam is safe, releases of mercury from dental amalgam are within acceptable exposure levels, and/or there is insignificant data to prove its hazards. For example, our PubMed literature search yielded 55 sources finding or suggesting “no risk.” Below is an abridged list of some of these sources, which suggested “no risk” for the following populations and scenarios:

- Children^{1129 1130 1131 1132}
- General health/general population and/or exposure levels^{1133 1134 1135 1136 1137 1138 1139 1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151 1152 1153 1154 1155}
- Pregnancy^{1156 1157 1158 1159 1160}
- Occupational^{1161 1162 1163 1164 1165 1166 1167 1168 1169 1170 1171}
- Other: Alzheimer’s disease,¹¹⁷² antibiotic resistance,¹¹⁷³ autism,^{1174 1175 1176} fatigue,¹¹⁷⁷ immune system,^{1178 1179} kidney function,^{1180 1181 1182 1183} multiple sclerosis,^{1184 1185 1186} and Parkinson’s disease¹¹⁸⁷

It merits consideration that the technology of studying mercury’s impact on human health has evolved over the past several decades, and some studies advocating the safety of dental mercury amalgam failed to take into account genetic factors, susceptible populations, metal allergies, and other variables that are now known to impact each person’s response to mercury.¹¹⁸⁸

Another area of concern in relation to research about dental mercury amalgam is agreeing upon the definition of “risk.” To illustrate this point, a number of scientific articles claim that dental mercury amalgam is safe for the “general population.” Yet, given the current knowledge that sensitivities, biological predispositions, and a gamut of other conditions influence an individual’s reaction to mercury exposure,¹¹⁸⁹ the concept of accurately applying safety to the “general population” becomes highly subjective. This also applies to evaluating dental mercury amalgam risks for specific health conditions such as Alzheimer’s disease, autism, or multiple sclerosis.

Further issues with defining “risk” for dental mercury amalgam arise when considering the impact these restorations might have on an individual for a short amount of time versus long-term exposure, especially since many individuals have these fillings in their mouths for many years of their lives.¹¹⁹⁰

In particular, research has shown that an individual accumulates a chronic dose of mercury ranging from “0.2 to 0.4 µg/day per amalgam-filled tooth surface, or 0.5 to 1 µg/day/amalgam-filled tooth, depending on age and other factors.”¹¹⁹¹ As detailed in other sections of this document, how each person processes mercury exposure is dependent on a wide-range of circumstances.

Practicing mercury-free dentistry [dentistry that does not place any new mercury amalgam fillings] and mercury-safe dentistry [dentistry that utilizes protective measures when removing existing mercury amalgam fillings] undoubtedly reduces the danger of chronic mercury exposure to dentists, their staff, dental students, and patients.

This is especially important considering that mercury exposures also occur from non-dental sources. For example, the issue of amalgam fillings contributing to human mercury exposures from fish consumption has been studied.^{1192 1193} The topic was discussed in 2013 by the European Food Safety Authority's Panel on Contaminants in the Food Chain (CONTAM). The EFSA Panel described the increased mercury danger from the combination of fish and dental amalgam: "The estimated exposure to inorganic mercury in Europe from the diet alone does not exceed the TWI [tolerable weekly intake]. Inhaled elemental mercury vapour from dental amalgam, which after absorption is converted to inorganic mercury, is an additional source that is likely to increase the internal inorganic mercury exposure; thus the TWI [tolerable weekly intake] might be exceeded."¹¹⁹⁴

Additionally, it is essential to acknowledge that there are various escalating levels of protection techniques for limiting mercury exposure during mercury-related dental procedures. Depending on the technique/s chosen, different results are reached in personal and patient protection levels from exposure. The more thorough the protection, the more complex and costly the technique, and as such, financial, cultural, and professional decisions are part of the process as to the level of protection ultimately used.

Overall, it is apparent that dental mercury amalgam and all dental restorative materials should be assessed for safety and biocompatibility with special consideration for all populations and all known risk factors.¹¹⁹⁵

DESCRIPTION OF IMPLEMENTING SUGGESTED ACTION AND RESOURCES:

Research has suggested that resin composites or compomers are used for 55% of direct dental restorations worldwide.¹¹⁹⁶ Thus, many dentists have already stopped using dental mercury amalgam; however, many of these dentists and others still require training in mercury-free dentistry [dentistry that does not place any new mercury amalgam fillings]. Since other countries have banned or strictly limited dental mercury amalgam, their dental schools and industry practices shed light upon how to make a complete transition away from dental mercury amalgam.

Yet, it must also be recognized again that since all dentists still must remove dental mercury amalgam fillings, dentists and dental students require training in mercury-safe dentistry [dentistry that utilizes protective measures when removing existing mercury amalgam fillings]. Essentially, properly applied protection techniques can minimize mercury exposure to dental workers, dental students, patients, fetuses, and other susceptible and sensitive populations.

The IAOMT has developed free dental education resources detailing implementation strategies for mercury-free dentistry [dentistry that does not place any new mercury amalgam fillings] and mercury-safe dentistry [dentistry that utilizes protective measures when removing existing mercury amalgam fillings], including information for dentists, physicians, health professionals, patients, and the general public. These resources include the following:

- [IAOMT's online learning videos, including dental education about mercury](#)
- [The IAOMT's Safe Mercury Amalgam Removal Technique \(SMART\)](#)
- [IAOMT's Dental Mercury Facts pages](#)
- More resources available at www.iaomt.org and www.theSMARTchoice.com

DISCLAIMER:

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