

Dental Amalgam: Public Health and the Environment

July 2016

California Dental Association
1201 K Street, Sacramento, CA 95814
800.232.7645 cda.org



Issue Summary

Dental amalgam is an alloy made by combining silver, copper, tin and zinc with mercury. Amalgam has been used to restore teeth affected by decay for more than a hundred years. More recently, other materials, such as composite resins, have provided dentists and patients with an option other than amalgam, and because composite restorations can match tooth color, they have become more popular than the silver colored dental amalgam. However, because of its greater durability and adaptability than alternative materials, amalgam is still considered the best option for certain restorations, especially where the filling may be subjected to heavy wear, or where it is difficult to maintain a dry field during placement. Also, because amalgam material is less costly than composite material, it often represents a more economical choice for patients.

Notwithstanding these benefits, because mercury is a principal ingredient in amalgam fillings, there has been a persistent concern about how dental amalgam might affect patient and dental staff health and the environment.

Dental amalgam has been the subject of attention by regulators and others because it contains elemental mercury as a major ingredient, and mercury in certain forms has toxic properties. The mercury in amalgam is not free mercury but is bonded within a very stable, durable alloy with other metals (silver, copper, tin, zinc and others), therefore its properties change when present in alloy form.

The elemental mercury in dental amalgam is the least potentially harmful of all forms of mercury. It differs in composition from methylmercury, which is highly toxic, and is the principal form of mercury for human exposure (through seafood). Elemental mercury isn't readily absorbed by the body and is usually excreted before it can be absorbed in tissue or organs. Methylmercury is produced when mercury binds with organic molecules in the environment. Mercury, which through a complex chemical process produces methylmercury, is usually released from industrial sources into the air and through wastewater, and the methylation process of mercury in the environment largely takes place in surface waters. Consequently, methylmercury can be found in various levels in fish and other aquatic life. Exposure to methylmercury is through ingestion, which results in methylmercury being found, in various degrees, through the entire food chain. Methylmercury is readily absorbed by living tissue and continues to accumulate in the body for many years.

Theories associating mercury in dental amalgam with serious illness have not been supported by reputable science. Mercury toxicity is determined by various factors: the form of mercury, route and duration of exposure, and dose. Measuring devices have improved over time and now allow very low levels of mercury to be detected,

but no cause-and-effect relationship has been established between the mercury in dental amalgam and any systemic illnesses in either patients or dental health care workers.

Federal, state and local environmental agencies regulate for levels of "total mercury" because it does not degrade and can change from one form to another, allowing it to migrate through the environment, though there is insufficient scientific evidence that dental amalgam in the environment is a significant source of methylmercury.

Nonetheless, it is prudent for dentistry to take steps to reduce the release of amalgam waste or any potentially harmful materials to the environment because dentistry's role as a public health profession naturally includes environmental stewardship. Organized dentistry encourages and supports constructive dialogue with individuals and organizations that further public health and environmental quality goals.

Safety

Findings from scientific research and major national and international health organizations support the use of dental amalgam as a safe and effective restorative material. Long-term studies also demonstrate that amalgam can be safely handled by dentists and other dental health care workers in occupational settings.

After a comprehensive review of research literature, the 1993 U.S. Public Health Service Report on Dental Amalgam provided the following conclusion on health risks for dental amalgam:

...current scientific evidence does not show that exposure to mercury from amalgam restorations poses a serious health risk in humans, except for an exceedingly small number of allergic reactions.

A 1997 USPHS report, updating its 1993 report, included the following conclusion:

In 1997, with input from a broad cross-section of scientists and dental professionals within USPHS, the FDA completed a review of nearly 60 studies that were published in peer-reviewed scientific literature and were cited by citizen groups that petitioned the agency for stringent regulatory actions against dental amalgam. The analysis...indicated that the current body of data does not support claims that individuals with dental amalgam restorations will experience adverse effects, including neurologic, renal or developmental effects, except for rare allergic or hypersensitivity reactions.

The Life Sciences Research Organization (LSRO) is an independent nonprofit organization that utilizes scientists from a variety of disciplines to analyze problems and issues that arise in biomedicine, health care, nutrition, food safety and the environment. In 2004, LSRO was commissioned by the National Institutes of Health, the U.S. Department of Health and Human Services and the U.S. Food and Drug Administration to conduct a survey of more than 950 scientific journal articles and research reports on the safety of dental amalgam. This literature survey included reports of panels with the U.S. Public Health Service, the World Health Organization, the European Commission, Australia and Health Canada, which had also looked into the safety of amalgam. The LSRO report concluded:

"[T]here is insufficient evidence to support a correlation between dental amalgam exposure and kidney or cognitive dysfunction; neurodegenerative disease, specifically Alzheimer's disease and Parkinson's disease; or autoimmune disease, including multiple sclerosis."

In a 2009 white paper entitled "FDA Update/Review of Potential Adverse Health Risks Associated with Exposure to Mercury in Dental Amalgam," the FDA's National Center for Toxicological Research concluded:

The exposures to mercury (primarily mercury vapor) in persons with dental amalgam restorations are not expected to exceed these health-based comparison values other than in rare cases with a very high number of amalgam surfaces, and in all cases are well below the mercury exposures observed to have adverse health effects. Thus, mercury exposure from dental amalgam is not believed by USPHS agencies and [the World Health Organization] to represent levels associated with adverse health effects in humans, including sensitive populations.

The FDA survey also cited:

Two recent prospective clinical trials conducted with sensitive subpopulations, i.e., children, and other large retrospective studies in adults provide important and relevant observations concerning the possibility that mercury amalgams might adversely affect health. In sum, the studies evaluated do not support the hypothesis that exposure to mercury via dental amalgam restorations causes adverse biological outcomes associated with neuropsychological function, low birth weight, multiple sclerosis and Alzheimer's disease.

The FDA white paper concluded:

Based on a critical analysis of 34 peer-reviewed scientific articles published primarily since 2003, an evaluation of literature reviews conducted by [the Agency for Toxic Substances and Disease

Registry (ATSDR)] (1999, 2005) and [the Environmental Protection Agency] (2002), and the health effects-based exposure reference values derived by those agencies, it is concluded that the peer-reviewed scientific information published since 1997 does not substantially change comprehension of the health risk of mercury in dental amalgam compared to previous analyses performed by USPHS.

A 2011 article entitled "Biocompatibility of Dental Amalgams," published in the *International Journal of Dentistry*, observed:

The literature show that mercury released from dental amalgam restorations does not contribute to systemic disease or systemic toxicological effects. No significant effects on the immune system have been demonstrated with the amounts of mercury released from dental amalgam restorations. Only very rarely have there been reported allergic reactions to mercury from amalgam restorations. No evidence supports a relationship between mercury released from dental amalgam and neurological diseases. Almost all of the declarations accessed by the internet stated by official organizations concluded that current data are not sufficient to relate various complaints and mercury release from dental amalgam.

The European Union concurs that use of dental amalgam does not jeopardize the health of patients:

...with respect to the debate about the possibility of causal relationships between the use of mercury containing amalgam and a wide variety of adverse systemic health effects and taking into account many studies and investigations into this putative causal link, there is no unequivocal evidence to support this possibility. These studies have included assessments in children and in pregnant and lactating women. It is generally concluded that no increased risks on adverse systemic effects exist and we do not consider that the current use of dental amalgam poses a risk of systemic disease.

The main exposure to patients of mercury from amalgam restorations occurs during placement or removal of fillings. There is a consensus that it is best to keep placed amalgam fillings and leave them in place, unless the filling is damaged or defective, or the individual has an allergic reaction to one of the components of the amalgam. Mercury vapor emitted from amalgam restorations during vigorous grinding of teeth or chewing has been measured, but not in an amount that is considered toxic or which would result in adverse health effects. One study concluded that a person would have to have as many as 500 amalgam fillings for the amount of mercury vapor released from amalgam to begin to show even subtle symptoms.

Numerous health advocacy organizations support continued use of dental amalgam:

- The Alzheimer's Association concludes, "According to the best available scientific evidence, there is no relationship between silver dental fillings and Alzheimer's" or other neurological diseases. The Association cites an article in the October 30, 2003, issue of the *New England Journal of Medicine* in arriving at this conclusion.
- The American Academy of Pediatrics includes on its website the statement that "An expert panel for the National Institutes of Health has concluded that existing evidence indicates dental amalgams do not pose a health risk and should not be replaced merely to decrease mercury exposure."
- The Autism Society of America, contrary to the claims of anti-amalgam advocates, maintains that while there is no known single cause for autism, the evidence indicates autism is caused by brain structure or function, with a strong link to genetics.
- The U.S. Environmental Protection Agency, writing on its website about exposure to mercury, cites the Centers for Disease Control and Prevention's finding that "there is little evidence that the health of the vast majority of people with dental amalgam is compromised, nor that removing amalgam fillings has any benefit effect on health."
- The Mayo Clinic, in its *Medical Edge from Mayo Clinic*, January 28, 2013, stated, "Amalgam is a safe and durable choice for fillings," and "an effective, long-lasting treatment for dental decay."
- The National Multiple Sclerosis Society's website states, "There is no scientific evidence to connect the development or worsening of MS with dental fillings containing mercury, and therefore no reason to have those fillings removed."
- The U.S. Food and Drug Administration states on its website, "Based on [the] evidence, FDA considers dental amalgam fillings safe for adults and children ages 6 and above. The amount of mercury measured in the bodies of people with dental amalgam fillings is well below levels associated with adverse health effects."
- The American Public Health Association, in a 2012 policy statement entitled "Dental Amalgam – Preserving a Proven Dental Material," stated, "In the case of dental amalgam, the preponderance of high-quality evidence indicates that there is no harm to humans, and the only suggestion of any adverse health effects comes from a small number of methodologically flawed studies."
- The National Institute of Dental and Craniofacial Research (part of the National Institutes of Health), in the 2006 report "Studies Evaluate Health Effects of Dental Amalgam Fillings in Children," found that "children whose cavities were filled with dental

amalgam had no adverse health effects. The findings included no detectable loss of intelligence, memory, coordination, concentration, nerve conduction or kidney function during the 5-7 years the children were followed."

Over time, measuring devices have improved such that very low levels of mercury in dental amalgam can be detected, but no cause-and-effect relationship has been established between the mercury in dental amalgam and systemic illnesses in patients or dental health care workers. Restorative materials have progressed such that dental amalgam use is declining as more patients and dentists choose newer, more natural-looking, tooth-colored restorative materials. Dentists and patients still value amalgam as the superior choice among restorative materials in numerous instances, and the California Dental Association and American Dental Association are therefore committed to protecting the patient-doctor decision to select this durable and effective material among the safe options available for restoring decayed teeth.

Environmental Impacts

Respected, peer-reviewed studies on amalgam's environmental impacts, primarily those impacts associated with dental office wastewater discharges, indicate no likely potential for significant environmental harm.

The environmental concern about mercury is that it does not degrade, but it can change from one form to another and will migrate through the environment. Under certain conditions in surface waters, microorganisms can convert some forms of mercury to methylmercury, which is highly toxic. Fish and other aquatic organisms can absorb methylmercury, and because fish cannot eliminate methylmercury from their tissue, methylmercury can bioaccumulate up the food chain. Regular consumption of fish with methylmercury in high enough concentrations can cause harm to both wildlife and humans.

The largest sources of mercury in the overall environment nationally are incineration of municipal and medical waste, and combustion of fossil fuels. In California, mercury occurs naturally in the cinnabar deposits around the San Francisco Bay area. Another large source is legacy-mining wastes from the state's gold mines, where mercury was used to extract gold from ore.

Dental amalgam has been the subject of attention by environmental regulators because it contains elemental mercury as a major component. The elemental mercury in dental amalgam is the least potentially harmful of all forms of mercury. The mercury in amalgam

is of a type that is contained within a very stable, durable alloy with other metals (silver, copper, tin, zinc and others) and consequently is not released into the body or the environment in any significant amounts. Mercury forms a strong bond with these other metals to form dental amalgam. High temperatures and certain chemicals, such as those used in EPA wastewater laboratory analyses, can separate mercury from the other metals in amalgam. However, most of the amalgam in dental wastewater remains bonded in particulate form, is heavy and is mostly captured by traps and filters in the dental office and in the grit chamber at wastewater treatment plants. It is highly unlikely that conditions that dissolve amalgam bonds exist in the environment. A laboratory test that simulated the sewer system environment to examine the disposition of amalgam in wastewater did not detect soluble mercury.

The discharge of waste dental amalgam into the environment has been reduced significantly in recent years simply through the reduction of the use of amalgam in dental restorations. While amalgam once accounted for the vast majority of restorations in the United States, by 2005 its use had declined to 31.6 percent of all restorations and has continued to decrease at an average annual rate of 3.7 percent. This decline in the use of amalgam is attributable to the emergence of alternative restorative materials such as resin composites; newer amalgam restorations lasting longer than in the past because of improved physical qualities of amalgam; and the reduced demand for restorations overall, through more effective decay prevention techniques, such as sealants, fluoride treatments and the continued expansion of community water fluoridation.

Historically, organized dentistry has been proactive in reducing the potential impact of amalgam discharge from dental offices into the environment. In 2002, an ADA-sponsored environmental assessment found 78 percent of amalgam waste could be captured through dental office adherence to then-current best management practices associated with handling amalgam, recovering amalgam waste and recycling. In 2007, ADA released revised best management practices for amalgam waste to help dental offices institute the precautions necessary to reduce the amount of dental amalgam discharged into local sewer systems. These practices include using precapsulated alloys; recycling waste amalgam; using chair-side traps, vacuum pump filters and amalgam separators; recycling extracted teeth that contain amalgam; and using appropriate line cleaners.

A scientific assessment conducted by ENVIRON International Corporation, based on a review by the EPA contractor Eastern Research Group (ERG), estimated that about 0.3 tons of amalgam-related mercury is discharged each year directly from the nation's sewage treatment plans. This amount represents about 1 percent

of the 31.25 tons of mercury used annually by dentists in the nation. These 0.3 tons would be reduced by nearly half – to 0.175 tons – if all dental practices that use amalgam were to install amalgam separators. Even without amalgam separators, the ENVIRON International assessment estimated that dentists captured approximately 77 percent of waste amalgam through the use of other best practices, such as chair-side traps and vacuum pump filters designed to remove amalgam before it enters the waste stream. Almost all of the remaining 22 percent of amalgam waste is captured by water treatment plants before the wastewater is discharged to surface water. In other words, approximately 99 percent of dental amalgam waste is captured in the office or by the sewage treatment plant prior to discharge into rivers, streams or lakes. Adding a separator allows the capture of that additional amalgam waste in the dental office.

ADA's voluntary activities to reduce amalgam discharge from dental offices, as exemplified by the MOU agreement with EPA and the NACWA, have been favorably received by environmental regulators and widely publicized through their networks to regulators throughout the country. These activities continue, and include:

- Developing guidelines or recommendations for managing waste in dental offices (best management practices), often as joint endeavors with environmental regulators;
- Distributing literature on waste management;
- Education and training programs or workshops for dentists;
- Fostering communication between dental societies and environmental regulators; and
- Promoting scrap amalgam recycling.

Wastewater regulations differ from community to community, and rightly so as local discharge limits for mercury, treatment plant permit conditions and limits, regulatory agency resources and priorities vary among the local sanitation agencies. Some agencies have proposed and implemented wastewater discharge permit programs that include dental offices. CDA supports the acceptance of voluntary efforts to reduce amalgam waste, or when a local agency is considering regulations, CDA advocates for rules consistent with the ADA Best Management Practices. Consequently, local agency waste reduction requirements applied to dental offices tend to follow the provisions of ADA's Best Management Practices. CDA maintains open communication with local sanitation agencies and strongly encourages local dental societies to meet with local agencies when contacted.



Best Management Practices (BMPs) for Amalgam Waste:

- Do not rinse amalgam-containing traps, filters or containers in the sink.*
- Do not place amalgam, elemental mercury, broken or unusable amalgam capsules, extracted teeth with amalgam or amalgam-containing traps and filters with medical "red-bag" waste or regular solid waste.*
- Recycle, or manage as hazardous waste, amalgam, elemental mercury, broken or unusable amalgam capsules, extracted teeth with amalgam, amalgam-containing waste from traps and filters. Empty dental amalgam capsules containing no visible materials may be disposed of as a nonhazardous waste, except as required by local regulations.*
- Collect and store dry dental amalgam waste in a designated, airtight container. Amalgam, which is designated for recycling, should be labeled "Scrap Dental Amalgam" with the name, address and phone number of your office and the date on which you first started collecting material in the container. In the past, dental amalgam scrap may have been kept under photographic fixer, water or other liquid. If you should encounter amalgam stored in this manner, do not under any circumstances decant the liquid down the drain and discontinue this practice in the future.*
- Keep a log of your generation and disposal of scrap amalgam; inspectors may ask to see this to verify that your office is managing it correctly. A generation and disposal log is a record of what you placed in the amalgam container, when it was placed in the container and when the container was picked up by or sent to a recycler or hazardous waste hauler.
- Check with your amalgam recycler for any additional requirements. Some recyclers do not accept contact amalgam (amalgam that has been in the patient's mouth); others may require disinfecting the amalgam waste. All recyclers have very specific packaging requirements.
- Separate excess contact dental amalgam from gauze that is retrieved during placement and place in an appropriate container.
- Use chair-side traps to capture dental amalgam.
- Change or clean chair-side traps frequently. Flush the vacuum system before changing the chair-side trap.
- Change vacuum pump filters and screens at least monthly or as directed by the manufacturer.
- Check the p-trap under your sink for the presence of any amalgam-containing waste.
- Eliminate all use of bulk elemental mercury and use only precapsulated dental amalgam for amalgam restorations.
- Limit the amount of amalgam triturated to the closest amount necessary for the restoration, i.e., do not mix two spills when one spill would suffice. Keep a variety of amalgam capsule sizes on hand to ensure almost all triturated amalgam is used.

- Train staff that handle or may handle mercury-containing material in its proper use and disposal.
- Install an amalgam separator compliant with ISO 11143.
- Do not use bleach to clean discharge systems as this may mobilize legacy mercury and amalgam in the system.

* California Code of Regulations Title 22 Section 66273.33(c)(4)(A)

Amalgam Resources

American Dental Association: Best Management Practices for Amalgam Waste – <https://www.ada.org/en/member-center/oral-health-topics/amalgam-separators>

U.S. Public Health Service: “Dental Amalgam: A Scientific Review and Recommended Public Health Service Strategy for Research, Education and Regulation,” 1993 –
<http://web.health.gov/environment/amalgam1/ct.htm>

“Dental Amalgam and Alternative Restorative Materials,” 1997 –
<http://web.health.gov/environment/amalgam2/Contents.html>

U.S. Food and Drug Administration: Medical Devices: About Dental Amalgam Fillings – <https://www.fda.gov/medical-devices/dental-devices/dental-amalgam-fillings>

Food and Drug Administration press release on Final Regulation on Dental Amalgam – <http://www.fda.gov/NewsEvents/Newsroom/Pressannouncements/ucm173992.htm>

White Paper: FDA Update/Review of Potential Adverse Health Risks Associated with Exposure to Mercury in Dental Amalgam – <http://www.fda.gov/medicaldevices/productsandmedicalprocedures/dentalproducts/dentalamalgam/ucm171117.htm>

Life Sciences Research Organization (LSRO): Review and Analysis of the Literature On the Potential Health Effects of Dental Amalgam –
http://www.lsro.org/amalgam/frames_amalgam_home.html

U.S. Environmental Protection Agency: Mercury in Dental Amalgam –
<https://www.epa.gov/mercury/mercury-dental-amalgam>

US EPA 2012 Effluent Standards Rulemaking: Proposed Guidelines for Dental Amalgam Effluent – <http://water.epa.gov/scitech/wastetech/guide/dental/index.cfm>

European Union, European Commission Scientific Committees on Emerging and Newly Identified Health Risks and on Health and Environmental Risks: “Tooth Filling Materials – Dental amalgams and alternative materials” –
http://ec.europa.eu/health/scientific_committees/opinions_layman/en/dental-amalgam/index.htm#4

California Department of Toxic Substances Control: Mercury Waste – <http://www.dtsc.ca.gov/HazardousWaste/Mercury/>

Mayo Clinic: Amalgam is a Safe and Durable Choice for Fillings –
<https://newsnetwork.mayoclinic.org/discussion/amalgam-is-a-safe-and-durable-choice-for-fillings/>