

ADA MERCURY HYGIENE RECOMMENDATIONS A REVIEW

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More than a decade ago, the ADA established recommendations for appropriate mercury hygiene within dental offices.

Recommendations are subject to periodic updates and change as new information and technology emerge.^[1] The ADA has established guidelines for the protection of dental healthcare workers and the environment. The National Institutes of Health has provided guidance concerning the reduction/elimination of mercury waste from healthcare facilities.^[2] Furthermore, dental service branches within the US military have taken a leadership role regarding mercury workplace safety.^[3-5]

This article reviews and elaborates on the ADA's 11-point mercury safety guidelines. Common workplace violations are highlighted, and steps for correction are cited. Practitioners can utilize this information to assist in development of an office protocol.

Restorative dentists who no longer offer amalgam services should not ignore mercury hygiene. Amalgam restorations are replaced or removed for a variety of reasons, including defective margins, recurrent caries, fractured tooth structure, and endodontic access. Even this more limited exposure to amalgam may pose a workplace or environmental risk. Dental personnel should not forget they are at greater risk of mercury exposure than the general population.^[6-12]

ADA RECOMMENDATIONS 1

1) "Train all personnel involved in the handling of mercury or dental amalgam regarding the potential hazard of mercury vapor and the necessity of observing good hygiene practices."

This can be accomplished with in-office staff training. Often, the employee designated as the OSHA educator will present information and training at a weekly or monthly staff meeting. State and local dental societies may offer such training to member dentists and their staff. These educational courses are a valuable tool to satisfy OSHA mandated guidelines for staff training on infection control and workplace safety from potential biohazards, including mercury.

Amalgam consists of approximately 50% mercury by weight.^[13] Mercury vapor release is of particular concern as a potential health risk. An estimated 75% to 80% of inhaled mercury vapor, which reaches pulmonary alveoli, will be absorbed into the blood.^[14-16] Prophylactic measures can be taken to substantially lower risks to dental personnel and the

environment.

Measures cited to follow will elaborate.

2) "Make personnel aware of the potential sources of mercury vapor in the operatory— that is, spills; open storage of used capsules; trituration of amalgam; placement, polishing or removal of amalgam; heating of amalgam-contaminated instruments; leaky capsules; and leaky bulk amalgam dispensers. Personnel also should be knowledgeable about the proper handling of amalgam waste and be aware of environmental issues. Some state dental societies have published waste management recommendations applicable to their state."

The dental profession has moved towards routine use of pre-encapsulated amalgam. Loading of elemental mercury and alloy powder onto opposite ends of a measuring balance beam is now obsolete. Scrap (or waste) amalgam handling poses a greater problem.



Figure 1. Scrap amalgam improperly stored in an unsealed open box, within a treatment room drawer. Also note the open spent amalgam capsules, which actually are of minor consequence in this unsafe and noncompliant situation.

Proper storage and recycling of waste amalgam has been a challenge. Because the focus of concern has been patient safety with amalgam,^[6,17,18] some clinicians may underestimate the importance of environmental or workplace risk. These incorrect assumptions may result in unrealized hazards and liabilities.

Some dentists improperly store scrap amalgam in open containers (Figure 1). Used amalgam-mix capsules containing small amounts of amalgam are sometimes improperly stored in an open, and not closed, manner. Waste amalgam and spent capsules may be inappropriately disposed of in the general office refuse, from which they later enter municipal landfills or incinerators. This source of mercury can enter ground water, or elevate the mercury level in the air.^[19,20] Adherence to ADA Recommendation No. 11 on methods for amalgam storage is advisable. (See discussion of Recommendation No. 11 later.)

The Vermont Dental Society and the National Wildlife Federation have jointly published guidelines for environmental safety.²¹ Special amalgam separator/ collector traps have been designed for dental wastewater. These are required in Germany, King County (Seattle), Washington, and many other regions.^[22] These separators have been specially engineered to remove elemental mercury and very small particulate amalgam, which will pass thorough standard dental operatory unit traps.^[23,24]



Figure 2. ISO (International Organization for Standardization) 11143 certified amalgam separator. These units protect municipal wastewater by collecting the 60% of waste amalgam and mercury that bypasses standard dental unit primary and secondary traps.



Figure 3. Internal floor surface of amalgamator (assuming no defective open seam) has collected scrap amalgam and beads of elemental mercury. Over time, amalgamators become contaminated to the degree of a biohazard. They represent a source of mercury vapor for dental personnel.



Figure 4. Scrap amalgam often collects on surfaces difficult to clean, such as the lumen of an amalgam carrier. Amalgam should be removed by ultrasonic cleaning tank, and collected and handled in accord with ADA recommendations. Autoclave temperatures generate dangerously high levels of mercury vapor. The mechanism should never be “freed” by holding the instrument in an open flame.



Figure 5. Left: New carbide bur has optimal cutting efficiency, which reduces preparation time and lowers the cutting temperature. Defective alloy may be removed in larger segments, which are more easy to collect, and present less surface area/volume for reduced mercury vapor release. Middle: After three autoclave cycles corrosion substantially dulls carbide bur. Preparation time and temperatures are elevated as cutting efficiency declines. Smaller slurry amalgam particulates are generated. *Right: Additional autoclave cycles have corroded the carbide bur to the extent that at alloy removal the bur exhibited complete metal fatigue. While in the patient’s mouth, the bur tip broke.*

Mercury-contaminated amalgam at or present another problem (Figure 3).^[25,26] Debris on any surface or working part of an amalgamator may include scrap amalgam, as well as beads of free mercury. A defective gap or seam opening will permit debris to escape from the amalgamator. Otherwise, risk is limited to mercury vapor exposure directly from the contaminated amalgamator.

Because of release of mercury vapor, the World Health Organization (WHO) has cautioned against heating of dental amalgam.^[6] The WHO specifically recommends that coolants be employed when polishing or removing amalgam.

Friction generates heat. Heat releases mercury vapor. The WHO states “open heating of amalgam should never be carried out...” (Note: In the case of crematoria, the WHO advises vapor collectors to protect air quality, as mercury is released from amalgam.)

Heating amalgam-contaminated instruments often occurs when incompletely cleansed instruments are autoclaved. Scrap amalgam frequently clings to the lumen of amalgam carriers, causing the mechanism to stick (Figure 4). Amalgam adheres to crosshatched surfaces of amalgam condensers and carving and finishing instruments.

Ultrasonic pre-cleaning prior to autoclaving is advisable. Examination of ultrasonic tanks often reveals amalgam debris. This potential source of mercury exposure must be collected, stored, and disposed of in a worker-safe and environmentally friendly manner. Residual waste amalgam subjected to high autoclave temperature will generate exceptionally high levels of mercury vapor.^[27] When venting autoclaves or any potential source of mercury vapor, proper air exchange is advised to protect employees.

Furthermore, heating a “sticky” amalgam carrier under a flame is sometimes used to free the mechanism clogged by waste alloy. This will produce potentially dangerous levels of mercury vapor in the immediate vicinity.

To reduce overhead costs, handpiece burs (even inexpensive single-use brands) may be used and sterilized multiple times (Figure 5). Handpiece cutting efficiency is dramatically reduced. In removing defective alloys, preparation time and cutting temperatures are elevated. These burs, subjected to excessive stress and corrosion of multiple cycles of autoclaving, exhibit metal fatigue. Cutting efficacy is dramatically reduced, prolonging cutting times and increasing operator exposure to mercury vapor and amalgam particulates. It becomes more difficult to segment defective alloy

into larger and safer particle size (see section 5). Frictional heat is elevated with use of these defective, dull burs, which may not only elevate levels of mercury vapor, but insult pulpal tissue.^[28,29] No study has specifically addressed the relation of poor-cutting, defective burs, with regard to elevated levels of mercury vapor. However, this is easily extrapolated from research demonstrating relatively high release of mercury vapor from the very limited and less invasive procedure of amalgam polishing.

3) "Work in well-ventilated spaces, with fresh air exchanges and outside exhaust. If the spaces are air-conditioned, air-conditioning filters should be replaced periodically."

Many practices are in full compliance with this recommendation, with office space that has been initially designed with adequate ventilation ductwork, fresh air exchanges, and filtration systems.

Numerous private companies will assist with facility design for optimal workplace ventilation.

In Sweden, the threshold limit for the breathing zone of dental personnel has been established at 30 µg Hg/m³ (cubic meter) air. Other nations may not have established safety thresholds, or there may be no monitoring of the air quality, even if standards are in place. Thus, currently in countries like the United States, it may be very difficult if not impossible to assess if a particular clinic affords its staff a safe breathing workplace environment.

Some facilities definitely have inefficient ventilation. As examples, older clinic settings or special facilities (prison dental clinics where building design may focus primarily on staff and inmate security) may not address concerns related to ventilation. Similarly, some offices may compromise on fresh air exchange in an effort to decrease threat of burglary or other crime.

Initial costs for proper ventilation and fresh air exchangers may seemingly be prohibitive when a clinical facility is being planned, and expenses are considered.

4) "Periodically check the dental operatory atmosphere for mercury vapor..."

Dosimeters should be used for routine monitoring of air-mercury levels. Hand-held mercury vapor analyzers can be used for rapid hazard assessment after a spill or cleanup. Many state and local dental societies have these devices available for loan to member dentists. It would be cost-effective for groups of dentists to pool their resources to accomplish recommended monitoring. Private environmental firms will also provide this

monitoring service.

This site of mercury contamination may not be easily observable, and mercury cannot be detected by odor. It cannot be assumed that such contamination does not exist, or if it does, that it has no consequence.

5) "Use proper work area design to facilitate spill contamination and cleanup. Flooring covering should be nonabsorbent seamless and easy to clean."



Figure 9. Clinician with protective eye wear, protective clothing, and surgical facemask.

Facemask must secure to facial contours including facial hair. No standard mask will filter mercury vapor or amalgam particulates smaller than 10 µm. Filtration protection varies for different masks.

Unfortunately, standard barrier techniques do not prevent pulmonary exposure to mercury vapor (Figure 9). The filtration pore size and a secure mask seal vary greatly from manufacturer to manufacturer with standard surgical masks.^[30] Some masks are far superior to others in filtering waste amalgam

particulate material. Masks should be changed frequently to assure effectiveness. No standard surgical mask can filter mercury vapor or amalgam particulate matter smaller than 10 μm .³¹ A poorly fitted mask, or one from an inferior manufacturer, will fare far worse. Several studies have examined the quantitative release and consequences to dental personnel of mercury vapor sourced to amalgam removal.^{32,33} Few research the problems of μm -sized amalgam particles, which have potential to travel through protective masks, and ultimately into terminal alveoli of the lungs.^[31]

Protective gloves, face shields, and barrier clothing should also be employed for cleaning amalgam collection traps, freeing clogged suction lines, and removing instruments from ultrasonic cleaners prior to autoclaving. The US Navy and US Air Force have established protocols to dispose of waste amalgam collected from traps prior to recycling.^[4,5]

6) "If possible, recap single-use capsules from precapsulated alloy after use. Properly dispose of them according to applicable waste disposal laws."

Recapping disposable capsules reduces mercury vapor emissions.^[34] Used capsules and scrap alloy sealed in a biohazard container can contribute to mercury air-contamination if incinerated with biomedical waste. Air quality and/or ground water may be compromised if amalgam-contaminated capsules are disposed of in standard municipal trash.

State certified and bonded amalgam-recycling companies are ideally suited to handle and process amalgam waste.

Dentists have been found liable for costs incurred in mercury cleanup when an unlicensed amalgam waste handler improperly disposed of scrap amalgam in a community landfill.^[35,36] Dentists are advised to check a recycler's EPA license number and insurance coverage.

7) "Use high-volume evacuation when finishing or removing amalgam. Evacuation systems should have traps or filters..."

As stated, improved filtration systems have been developed to remove nearly all mercury/amalgam in wastewater from the dental operator. Local, state, and national governments are increasingly requiring this level of filtration.^[37,23,24]

Dentists in the past practiced without an assistant, and with little or no high-volume evacuation. When excessive debris, including waste amalgam, accumulated in the patient's mouth, the patient was instructed to rinse into a cuspidor. The wastewater

emptied directly into the publicsewersystem.

The acceptance of four-handed dental practice, with high-volume evacuation, has lessened this source of mercury contamination. Unfortunately, quantities of waste amalgam and mercury may remain in plumbing traps, or office cabinet or drawer space from clinical practice of earlier times. This contamination may have environmental liability and workplace safety consequences for a practitioner many years later. The current dentist in that practice and/or facility may assume responsibility for previous oversight of mercury hygiene.

Some dentists may prefer to prepare teeth without water spray to improve visibility.

The absence of a water spray elevates the temperature and may damage pulpal tissue, as well as increase production of mercury vapor when removing amalgam.

Dental professionals are exposed to approximately ten times the concentration of mercury vapor without this precaution.^[38] Handpiece water mist/spray also help trap alloy debris into slurry, for ease in suctioning and removal. High-volume evacuation and water spray function together to reduce mercury vapor levels and waste particulate alloy from the breathing area of dental personnel.

Marginally functional suction pumps and clogged vacuum hoses do not allow proper evacuation. These situations should be remedied.

8) "Salvage and store all scrap amalgam (that is, noncontact amalgam remaining after a procedure) in a tightly closed container, either dry or under radiographic fixer solution..."

Storage of scrap amalgam under water is associated with mercury going into solution. Disposal of mercury-contaminated water then becomes a problem. Scrap alloy stored in radiographic fixer solution will not have mercury go into solution. However, disposal of fixer solution may present a chemical waste problem in and of itself. This solution should be disposed of in accordance with environmental waste management laws and guidelines. Waste management companies that collect and process used radiographic fixer chemicals may not be equipped to handle mercury wastewater.

If scrap amalgam is stored dry, mercury vapor may escape when the container lid is removed. This occurs each time the container is opened and closed. Adequate ventilation is essential.

9) "Where feasible, recycle amalgam scrap and

waste amalgam. Otherwise, dispose of amalgam scrap and waste amalgam in accordance with applicable laws..."

As stated, environmental law usually attaches legal liability for cleanup to the originator or generator of the biohazard waste (the dental practice). Ignorance of the related law is no defense.

10) "Dispose of mercury-contaminated items in sealed bags according to applicable regulations..."

Again, municipal sewage, landfill, and incineration are not equipped to deal with mercury waste. Mercury-contaminated items require special handling and disposal by licensed carriers. Most state dental societies provide lists of such companies.

11) "Clean up spilled mercury properly using trap bottles, tapes or freshly mixed amalgam to pick up droplets, or use commercial cleanup kits. Do not use a household vacuum cleaner."

DISCUSSION

Dentistry has made important progress in the area of mercury hygiene for workplace and environmental safety. Today, many practices are in compliance with the ADA recommendations. This article is intended to assist practices in addressing complete compliance, and can assist with in-service training. It is important to remember that during in-service training mercury hygiene techniques should be explained simply, and not in complex terms. A time for questions and answers should be provided. It is important to remember that auxiliaries may actually be at greater risk of mercury exposure than dentists.^[38]

Some dental clinics offer on-site testing for mercury vapor levels and employee screening of urinary mercury levels. This is very significant, as a limited number of dental clinics demonstrate dangerously high mercury levels.^[38,39] The distribution of dentists with elevated levels of mercury is not uniform. While a majority display relatively low levels of urinary mercury, a smaller number demonstrate high levels.

This implies compliance with mercury workplace safety guidelines is not universal for dentists and auxiliaries. A safe work environment should be a right, and not a privilege enjoyed by some but not all.

Amalgam has survived as a restorative material, in large measure, because of low cost and clinical reliability.^[6,17,18] The fees charged for amalgams have been questioned.⁴⁰ When practitioners examine associated expenses involved with amalgam placement or removal, workplace and

environmental safety should be considered. Increasing government regulations regarding dental mercury management are inevitable. These government directives will cost money to implement. It may be time to examine the true short- and long-term costs associated with the use of amalgam as a restorative material.

CONCLUSION

Organized dentistry is to be lauded for advancing workplace and environmental mercury hygiene safety. Local and state dental societies, the ADA, and the US military dental services have made contributions. Compliance with ADA mercury hygiene recommendations requires time, effort, and resources, but compliance is required.

Debate regarding the continued use of amalgam as a restorative material is beyond the scope of this article. This is an issue of informed consent and personal choice. For now, all restorative dentists must address mercury safety.

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