The Environmental Impact of Dentistry

Margot Hiltz, *MSc, DDS*

Auteure-ressource

Dre Hiltz
Courriel : *margothiltz@hotmail.com*

SOMMAIRE

Les dentistes doivent reconnaître que certains matériaux et certaines procédures utilisés dans la prestation des services de soins dentaires peuvent être préjudiciables pour l'environnement. Parallèlement à cette prise de conscience, ils peuvent commencer à prendre des mesures pour réduire au minimum la production de ces déchets et leurs effets potentiels sur l'environnement. Cet article traite de certains déchets communs (amalgame dentaire, plomb, argent, déchets biomédicaux, déchets de bureau ordinaires) et propose des suggestions pratiques pour réduire l'impact de notre profession sur l'environnement.

Mots clés MeSH : dental waste; environmental pollutants/adverse effects; environmental pollution/prevention & control; medical waste disposal

Pour les citations, la version définitive de cet article est la version électronique : www.cda-adc.ca/jcda/vol-73/issue-1/59.html

Dentistry is a profession dedicated to promoting and enhancing oral health and well-being. To accomplish these goals, dentists use a variety of materials and equipment. Unfortunately, some of the materials that are currently in use — including heavy metals and biomedical waste — present potential challenges to the environment. This paper addresses the environmental impact of dentistry and describes measures that can be taken by dental staff to reduce the production of potentially harmful and general wastes.

Mercury

Dental Amalgam

Although individual dentists generate only small amounts of environmentally unfriendly wastes, the accumulated waste produced by the profession may have a significant environmental impact.[1–3] Of much concern in recent years has been the impact of heavy metal contamination of water systems by dentists, particularly through the production of dental amalgam waste. Although dental amalgam is a durable, cost-effective and long-lasting restorative material,[4–8] it contains mercury, silver and other metals that can enter the environment.[8–12] Mercury is the heavy metal of primary concern, making up to 50% by weight of dental amalgam.[3,13,14] Mercury is bioaccumulating and is known to have toxic effects in plants, animals and humans.[2,8,15–17] The scientific literature fails to identify a causal relationship between dental amalgam and adverse health effects, likely because the forms of mercury associated with dental amalgam are elemental and inorganic,[18,19] which are less toxic than organic mercury.

The placement and removal of dental amalgam restorations generate solid and particulate wastes that can enter the environment if they are not properly captured and managed. Once in the environment, changes in pH, oxygen availability, temperature, presence of other ions and actions of abrasion and corrosion[2,11] can allow the mercury in amalgam to be used by bacteria, which are able to convert it to the more toxic organic methylmercury.[8,10,15,17] In bioavailable form, organic mercury can enter the food web, where it tends to accumulate in higher organisms, particularly fish and birds.[2,6,8,10,13,20–22] This has led to restrictions on human consumption of certain fish species to minimize the potential adverse health effects.[10,23,24] Although

it has not been demonstrated that the mercury in dental amalgam poses a direct threat to the environment, the practical approach to waste disposal by dental practitioners is to reduce its potential environmental impact.

Dental Amalgam Waste Products

During the placement and removal of dental amalgam restorations, a variety of waste products is generated[14,25]:

- elemental mercury vapour — released from dental amalgam alloy
- dental amalgam scrap — the amalgam particles that have not come into contact with the patient (i.e., particles remaining in the dappen dish following restoration placement)
- amalgam waste — the particles that have come into contact with patient secretions (e.g., particles generated during carving and restoration removal procedures)
- amalgam sludge — the fine particles present in dental office wastewater, commonly trapped in chair-side traps and vacuum filters.

Best Management Practices

Approximately 50% of environmental mercury is from natural sources, whereas approximately 42% of human-generated mercury pollution results from the combustion of fossil fuels.[17] Currently, it has been estimated that dentists contribute between 3% and 70%[6,10,17,26,27] of the total mercury load entering wastewater treatment facilities. Source elimination and reduction[12,14,25,28–31] are our best defences against environmental mercury contamination, particularly as the behaviour of dental amalgam components in the environment is not fully known.[2,14,29,32]

Practitioners are encouraged to follow "best management practices" in the handling and disposal of dental amalgam[14,25,30,33,34] to limit its potential environmental effects. Best management practices apply to a variety of hazardous wastes and depend on the type of waste in question. They are designed to provide guidelines to practitioners to limit the occupational and environmental hazards of a particular substance.[14] For mercury, best management practices are designed to address the various forms that are used and generated in the dental office. Practitioners are advised to use precapsulated dental amalgam to reduce the risk of liquid mercury spill or clinic–environmental contamination. Alternative restorative materials (i.e., composite resin, ceramic or other metal alloys) can be used, when indicated. Limiting the amount of dental amalgam triturated for a procedure also reduces the amount of waste generated.[14,25,30,33,34]

Practitioners are legally responsible for the collection, storage and disposal of both gross debris and fine amalgam particles removed via high-volume suction.[9,12,35,36] At present, many dental offices have chair-side filtration devices, as well as secondary filters to protect vacuum pumps. These devices trap larger particles of dental amalgam.[3,7,10,12,21,28,36,37] Chair-side traps have been found to be approximately 68% effective in their removal of amalgam particles from dental wastewater, while the average vacuum filter is approximately 40% effective.[3] A number of ISO 11143-certified amalgam separators are able to reduce amalgam particles in dental wastewater by more than 95%.[3,8,10,14,22,30,33,37–39] These devices separate the fine particles (generated during restoration finishing, polishing and removal procedures) from wastewater,[6,12] thereby limiting the amount sent to wastewater management facilities or the environment. Installation of these devices is mandatory in several regions, including Ontario, Saskatchewan, metropolitan Montreal and the Capital Regional District (including the city of Victoria and surrounding areas) in British Columbia. Although Manitoba currently has a voluntary policy regarding the installation of dental amalgam separators in dental offices, the current rate of compliance is 97% (Dr. Mike Lasko, registrar of the Manitoba Dental Association: personal communication, February 2, 2006).

Once collected, mercury and dental amalgam waste should be handled in the same manner as all hazardous waste; staff members should be properly trained and should use gloves, masks, gowns and protective eyewear when disposing of amalgam waste.[14,25,30] Dental amalgam scrap as well as amalgam waste gathered by filters and separation devices should be collected periodically and stored in a labelled, leak-proof container[9,10,30] (e.g., in a dry mercury-vapour suppressant system[40]). Contact and noncontact amalgam waste should be stored in separate containers, as reclamation of the components can be complicated by the need to decontaminate contact waste.[14] The proper storage of dental amalgam will also reduce the amount of elemental mercury vapour that enters the work environment.

As dental practitioners, we are responsible for ensuring that the waste carriers we use are registered and qualified to handle the wastes we produce. Waste storage containers should be collected for reclamation by a registered agency.[2,9,10,14,21,25,29,30,41] Ideally, these wastes should be recycled,[10,12,25] but not all hazardous waste collection agencies are qualified or able to perform this service. It is important to find out what forms of dental amalgam waste are accepted by a particular waste carrier and how that company prefers the waste to be stored.[14,25,42] A recent review by McManus and Fan[42] provides an excellent outline of some of the questions that should be asked before selecting a hazardous waste carrier.

Regardless of the means of disposal of dental amalgam, practitioners should not flush contaminated wastewater down sinks, rinse chair-side traps or vacuum filters in sinks, nor place material containing dental amalgam in general garbage or waste to be incinerated.[6,9,10,21,22,25,29,30,41] These practices release mercury into the environment and negate the profession's efforts to reduce environmental mercury contamination.

Table 1 Legislated limits on the level of mercury in wastewater in various Canadian municipalities

Municipality	Mercury limit (mg/L)	Bylaw
Calgary[47]	0.01	Sewer Regulation Bylaw no. 24M96; Schedule A, Section 8(1)g
Edmonton[48]	0.1	Sewers Use Bylaw no. 9675; Schedule B, 1(b)xi
Grand Prairie[49]	0.1	Water-Utility Bylaw C-1139; Schedule C, Section 25.10
Montreal[50]	0.05	Administrative Codifications of Bylaws; Article 11 (7), b.L. 87-2, art. 3, b.L. 87-3, art. 3
Toronto[51]	0.01	Sewers, Chapter 681 of the Municipal Code; §681-2
Vancouver (Capital Regional District)[52]	0.02	Bylaw no. 2922: Sewer Use Bylaw no. 5; Schedule B
Victoria (Capital Regional District)[52]	0.02	Bylaw no. 2922: Sewer Use Bylaw no. 5; Schedule B
Winnipeg[53]	0.1	Sewer Bylaw 7070/97 Part 5, 25(6)(g)

Source: Compiled by Pamela Aloisio (Environmental Policy Branch, Alberta Environment), December 14, 2005.

Amalgam Separators

Canadian dentists produce an estimated 781 kg of amalgam waste and sludge every year,[17,43] but the actual amount may be as high as 2,253 kg a year.[44] If practitioners who routinely place and remove amalgam restorations were to install amalgam separators, the amount of waste released into the environment would be dramatically reduced.[17,44] Although based on mailed surveys with a relatively poor response rate (44%), one Ontario investigation determined that the amount of mercury contributed to wastewater by dentistry would drop from an estimated 27% to 0.54% if all practising dentists in the province were to install amalgam separation units.[27]

Separation technology is based on sedimentation, filtration or centrifugation of the dental amalgam particles from wastewater.[3,6,10,14,28,41,42] Some devices use a combination of these methods, in addition to ion exchange.[14,28,42] The proper amalgam separation unit must be selected carefully as not all units are able to work efficiently in every physical arrangement.[42,45] Some units are placed before vacuum pumps, others after. Some require considerable space to house the unit, while others are compact. Costs of the device include not only the purchase price and installation costs, but also the cost of maintenance, replacement of filters and canisters and waste disposal.[30,42] Several reports outline these considerations and list the questions that should be posed when selecting a unit for a particular dental office.[14,30,42]

Memorandum of Understanding

Dental amalgam is recognized as a safe and practical restorative material[4,5]; however, due to the potential environmental impact of mercury, government regulations have become increasingly stringent regarding industrial and intentional (i.e., dental amalgam) mercury use and its subsequent passage into the environment.[2,8,10,12,14,22,28,29] A Memorandum of Understanding between the Canadian Dental Association (CDA) and the Canadian government aimed to reduce mercury release from dental amalgam by 95% as of 2005.[12,22,46] This voluntary effort encouraged by CDA is intended to promote high moral and ethical standards within the dental profession regarding the dental amalgam issue. To accomplish the 95% reduction, institution of best management practices is encouraged, as well as the installation of chair-side traps, vacuum filters and ISO-certified amalgam separators.

These efforts to decrease dentistry's production of dental amalgam waste are an attempt by the profession to deter the institution of increasingly stringent limits on waste levels by individual regions or municipalities. Some areas have already begun to impose strict limits on the amount of dental amalgam and mercury permitted in dental wastewater (**Table 1**), which may not be achievable even after the installation of an amalgam separating device.[14,28] As levels of mercury in wastewater are set by individual municipalities and jurisdictions, dental practitioners must consult local environment authorities to determine the regulations in their own region.

Silver

Silver is another heavy metal that can enter our water system via improper disposal of dental office waste. Although silver is a component of dental amalgam, the silver thiosulfate in radiographic fixer (a solution normally used in the processing of dental radiographs) presents a greater environmental concern.[10,30] Some forms of silver are more toxic than others; for example, silver thiosulfate is less toxic than free silver ions.[10,30] Again, limits for silver concentration in wastewater are set by individual municipalities and jurisdictions and can be obtained through local environment authorities.

Used radiographic fixer must not be washed down the drain. The best way to manage silver waste is through recovery and recycling. Dentists can install in-house silver recovery units to salvage the silver themselves, allowing for

some monetary return on the equipment investment when the silver is later sold.[10,30] These units generally recover silver ions from the waste solution through displacement of iron ions or through a closed-loop electrolytic system that recovers not only silver for reuse, but also the radiographic fixer. Alternatively, the waste can be collected by a registered agency certified to carry and manage the waste.[10,30,54]

Another common waste product in the dental office, unused film should also not be placed in the general waste. Unused films contain unreacted silver that can be toxic in the environment. Safe disposal can generally be accomplished by simply contacting the supplier of the product and returning the waste for recycling. Alternatively, a certified waste carrier can be contacted to dispose of the waste, ideally by recycling.[10,30]

With recent advances in radiographic technology, digital imaging is becoming a popular means of obtaining dental radiographs. Among its advantages are reduced radiation exposure and the absence of chemical image processing.[10] Therefore, incorporation of digital imaging within the dental office can greatly reduce the amount of silver waste generated.

Lead

An additional byproduct of traditional radiography is the lead shields contained in each film packet. Although the lead shields themselves are relatively small, the cumulative waste produced can be considerable.[55] An added benefit of digital radiography is the reduction in lead waste production. Lead, like mercury and silver, is toxic and persists in the environment.[10,55] Even at low levels of exposure, lead exerts adverse health effects on both children[56,57] and adults.[58,59] Reducing environmental lead contamination by dental practitioners is an inexpensive and easy task.[10,55] The lead shields from film packets merely have to be collected and returned periodically to the manufacturer for recycling.[10,30,55] The only cost is for postage. Unfortunately, some manufacturing companies report that only about 5% of products sold are returned. In part, it appears that this is due to a lack of awareness of the offered service.[55]

Biomedical Waste

Biomedical waste encompasses materials capable of causing disease or suspected of harbouring pathogenic organisms[60]; it includes blood-soaked gauze, tissues and syringes,[60–62] although not extracted teeth. Non-sharp biomedical waste products should be stored in a yellow bag that is properly labelled with a biohazard symbol. Sharps (i.e., syringes, suture needles) should not be included in the bagged general or biomedical waste, but should be stored in a puncture-resistant, leak-proof, properly labelled container until collection and incineration.[30]

Currently, Canadian guidelines[61,62] for the storage and management of biomedical wastes are under revision. These practices can be modified by provincial and territorial governments and municipalities; therefore, it is best to contact local environment and waste transport authorities to ensure that proper procedures and regulations are followed within each jurisdiction.

General Office Waste

Although this article attempts to address some of the larger issues relating to the environmental impact of dentistry, dental staff can also implement a variety of other practices to make the dental office more environmentally friendly. Purchase of products with minimal packaging and use of reusable plastic containers (e.g., for cleaning and disinfecting solutions) can reduce general waste production.[30] Products made from recycled or partly recycled materials can also be used (e.g., cotton or wool rolls, paper towels).[10,30,63] Energy-efficient lighting and temperature regulation can limit office energy use. Single-spaced printing and use of both sides of pages can decrease the amount of paper used in the dental office.[10]

Conclusions

Dental practitioners are becoming increasingly concerned about the potential impact of dentistry on the environment and often take voluntary measures to reduce the production and release of environmentally unfriendly wastes from their practices.[7,10,11,22,46,63] As health practitioners, we should be concerned with promoting not only human health and well-being but also that of the environment. A proactive approach will allow our profession to succeed in an era of increased public environmental concern and environmentally protective legislation. It is not only our legal obligation to provide dental services that benefit the public at minimal expense to the environment, but also our moral and ethical obligation.

THE AUTHOR

Acknowledgements: *I thank Dr. Elliott Sutow for his guidance and feedback during the initial stages of manuscript preparation. The assistance of Pam Aloisio (Alberta Environment) and Jeff Paterson (Environmental Protection, Saskatchewan) was also greatly appreciated.*

Dr. Hiltz *is an associate in a private practice in St. John's, Newfoundland.*

Correspondence to: *Dr. Margot Hiltz, Regatta Dental Centre, Regatta Plaza II, Suite 113, 84–86 Elizabeth Ave. East, St. John's, NL A1A 1W7.*

The author has no declared financial interests.

This article has been peer reviewed.

References

The complete list of references is available in the electronic version of this article at www.cda-adc.ca/jcda/vol-73/issue-1/59.html.