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MERCUKY AMALGAM FILLINGS: HUMAN AND ENVIRONMENTAL ISSUES FACING THE DENTAL PROFESSION

Todd Miller*

INTRODUCTION

In dental offices around the world, cavities are treated by drilling holes in patients' teeth and filling the abscesses with a compound known as dental amalgam filling. Also known as "silver fillings," dental amalgam is composed of a mixture of 45 to 52 percent mercury, 35 percent silver, and varying portions of copper, zinc and tin. Mercury, a heavy metal, is used in the amalgam mixture because, although it is liquid in its free state, when combined with other metals, it forms a paste that hardens within minutes and provides the mixture with strength and cohesiveness. Overall, amalgam is a popular material for filling cavities because it is strong, durable, and relatively inexpensive. Amalgam is used in about half of the 200 million cavity-filling procedures performed annually, while the other half of cavity fillings are done with such materials as gold, ceramics and plastics.

The modern dental amalgam was introduced in 1812 by British chemist Joseph Bell as a silver paste, which was a combination of coins and mercury. In the United States during the 1800s, however, concern of the American Society of Dental Surgeons regarding possible mercury toxicity led to mercury usage becoming an issue of malpractice. In addition, all Society members were forced to sign an oath not to use mercury-containing materials. Nonetheless, use of mercury fillings

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2 Id.
3 Id.
6 Id. (citing M. RING, DENTISTRY, AN ILLUSTRATED HISTORY (Harry N. Abrams ed., 1985).
increased, because it offered dentists an economic advantage; and because the fillings were simple to use and durable in the mouth. By 1856, the American Society of Dental Surgeons was forced to disband due to dwindling membership caused by the debate over the mercury filling issue.\(^7\) In its place rose the American Dental Association (ADA), which was founded by dentists who advocated silver amalgam-mercury use in dentistry.\(^8\)

In the 1920s, controversy once again erupted over amalgam fillings upon publication of articles and letters by a German chemistry professor, Alfred Stock, who attacked mercury filling usage for possible toxic effects.\(^9\) The debate raised by Stock soon abated, however; and the dental profession's favorable opinion regarding amalgam fillings was restored. Interestingly, the ADA's early position regarding the safety of mercury filling material was based upon the erroneous belief that mercury could not escape from a dental filling, a belief widely held at a time when there existed no instrumentation to measure this possible event. Although mercury has now been scientifically demonstrated to escape amalgam fillings, the ADA maintains that any mercury vapor that does escape dental fillings is inadequate to cause harm to human health.\(^10\)

In fact, the ADA is so supportive of mercury amalgam fillings, that it has even amended its code of ethics, making the removal of serviceable mercury fillings unethical conduct if:

(a) the reason for removal of the filling is to "eliminate a toxic material from the human body;" and

(b) if the recommendation to remove the filling is made solely by the dentist.\(^11\)

In the ADA's view, a dentist that places mercury material in a filling, and recommends its safety to the patient, is acting in an ethical manner.

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\(^7\) Vimy, supra note 5.

\(^8\) Id.

\(^9\) Id.

\(^10\) Taylor, supra note 1.

Conversely, if the dentist suggests to the patient that mercury fillings may be potentially harmful or result in exposure to unnecessary mercury, the dentist is acting in an "unethical manner." Consequently, clinically serviceable mercury fillings can only be "ethically" removed if done solely for aesthetic reasons at the request of a physician or patient, but absent any prompting by the physician.\textsuperscript{12}

This article discusses two issues that surround the use of mercury in the dental industry. First, the risk to humans caused by exposure to mercury vapor in their mouths, and in the dental office, will be examined. Second, this article will explore the risk posed to the environment, and potentially to humans, as a result of improper disposal of mercury-contaminated dental waste.

\textbf{POTENTIAL HEALTH HAZARDS FOR HUMANS}

Over the past few years, several studies have reported that dental amalgam fillings continuously leak small amounts of mercury into the oral cavity.\textsuperscript{13} Vaporization of the mercury from dental fillings is further intensified by chewing, tooth brushing and consumption of hot liquids.\textsuperscript{14} After mastication or tooth brushing, it takes almost ninety minutes for the rate of mercury vaporization to decline to pre-chewing level.\textsuperscript{15} In addition, a greater number of fillings over a larger chewing surface area lead to even higher levels of mercury.

In the late 1970s, University of Iowa researchers demonstrated that chewing increases the levels of mercury vapor in the breath of individuals with mercury amalgams.\textsuperscript{16} These researchers also found corroded fillings release even more mercury vapor.\textsuperscript{17} In addition, other studies have demonstrated that brushing filled teeth increases the level

\textsuperscript{12} See Vimy, \textit{supra} note 5.


\textsuperscript{14} Murray J. Vimy & Fritz L. Lorangeider, \textit{Intra-oral Air Mercury Released From Dental Amalgams}, 64 DENTAL RES., 1069, 1069-71 (1985).

\textsuperscript{15} Id.

\textsuperscript{16} Peggy O'Mara, \textit{What To Do With A Mouthful of Mercury}, MOTHERING, Mar. 22, 1996, at 32 (citing C.W. Svare et al., \textit{The Effect of Dental Amalgams on Mercury Levels in Expired Air}, 60 J. DENTAL RES. 1668, 1671 (1981)).

\textsuperscript{17} Id.
of mercury vapor in expired air, and that when exposed to mercury, individuals inhale and absorb as much as 80 percent of the vapors. Even human autopsy evidence has indicated that brain and kidney tissues contain significantly higher amounts of mercury in individuals with mercury fillings, and the concentration of mercury in the brain of subjects with mercury fillings correlate directly with the number of fillings present.

Recent experimentation on sheep and monkeys suggests that dental mercury accumulates in all tissues on the adult and is at its highest level in the kidney and liver. In fact, human studies have recently shown an association between urinary mercury excretion and the presence of mercury fillings. These results corroborate the results of human autopsy studies. Of particular interest, is the potential effect of mercury fillings on the unborn child. In studies where fillings were installed in the teeth of pregnant sheep, mercury amalgam was shown to cross the placenta and accumulate in the developing fetus within two days of the filling’s installation. The mercury was found at the highest level in the fetal liver and the mother’s milk, suggesting an additional form of transmission to newborns.

During the past two decades, more concerns have been raised about possible adverse medical side effects from the mercury in dental amalgam fillings. It has been suggested that mercury exposure is responsible for a wide variety of systemic ill effects in some patients,

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18 Id.
19 Id. (citing Sam Ziff & Michael Ziff, D.D.S, Infertility and Birth Defects: Is Mercury From Silver Dental Fillings an Unsuspected Cause?, BioProbe, Orlando, Fla., at 102 (1987)).
21 Vimy, supra note 5 (citing G. Danscher et al., Traces of Mercury in Organs from Primates with Amalgam Fillings, 52 EXP. MOL. PATH. 291-299 (1990).
22 Vimy, supra note 5 (citing I. Gerhard, 38 CLN. LAB 404, 404-411 (1992)).
23 Id.
24 Vimy, supra note 5 (citing Murray J. Vimy et al., Maternal-Fetal Distribution of Mercury Released from Dental Amalgam Fillings, 258 AM. J. PHYSIOL. R939, R939-945 (1990)).
25 Id.
26 Id.
27 Matthew M. Clark, Medical Care of the Dental Patient, 52 AM. FAM. PHYSICIAN 1126 n.4 (1995).
including immune suppression, neurotoxicity, renal impairment, obstetric complications, multiple sclerosis and conditional symptoms such as headache, fatigue and depression.²⁸

In 1991, three North American universities published a collaborative paper showing that oral and intestinal bacteria exhibit a significant increase in antibiotic resistance within two weeks of mercury filling placement.²⁹ Antibiotic resistance is a particularly significant issue in medicine today, since 30 percent of all hospitalized patients in North America receive antibiotic therapy and ten of the top twenty generic drugs prescribed in 1990 across the United States were antibiotics.³⁰ Microbiologist Anne O. Summers believes that mercury fillings play a large role in the spread of drug resistant bacteria.³¹ Summers research suggests that once a gene gets exposed to mercury it is primed to resist both the toxic effects of the mercury as well as the infection fighting effects of antibiotics.³²

The ADA has publicly disagreed with Summers’ argument. In fact, Terence Donovan, a researcher at the University of Southern California at Los Angeles speaking for the ADA, has alleged that the data in Summers’ study does not support the conclusion that mercury-based amalgam contributes to drug resistant infections in humans. According to Donovan, “from the public’s point of view, silver amalgam is the safest material [the dental industry] can use.”³³

Nonetheless, at the University of Arkansas, studies have suggested a connection between mercury exposure and neurodegeneration. According to these studies, mercury affects brain proteins responsible for the formation of brain neurons, creating neurofibrillar tangles which are a characteristic of Alzheimer’s disease.³⁴ In one human autopsy

²⁹ Id. 
³⁰ Id.
³² Id. 
³³ Id.
³⁴ Vimy, supra note 5 (citing Fritz L. Lorscheider, *Abstract of Presentation at the 12th International Neurotoxicology Conference*, Univ. of Arkansas Medical Ctr., Hot Springs (Oct. 30 - Nov. 2, 1994)).
study, brain tissue from people with Alzheimer's disease at death were compared with an age-matched group of control brains from subjects without Alzheimer's disease. The only significant difference in metal content between the two groups of brains was mercury, which was found to be considerably higher in the Alzheimer's group.\textsuperscript{35}

It should be noted that mercury amalgam treatment has been severely regulated in Sweden, Germany and Austria. The Swedish dental association has even publicly admitted that mercury amalgam is an unsafe substance based on a 1987 report commissioned by the Swedish government to examine the effect of mercury exposure from dental amalgams.\textsuperscript{36} The panel concluded that mercury fillings were unsuitable from a toxicological point of view. Based on the panel's advice, the Swedish health department announced that steps would be taken to eliminate dental amalgam usage recommending that mercury filling treatment on pregnant women be stopped to prevent mercury damage to the fetus.\textsuperscript{37} As of July 1, 1995, Sweden had eliminated the use of mercury amalgam on children and adolescents, and a complete ban of mercury amalgam fillings for adults is projected for 1997.\textsuperscript{38} Austria has initiated a similar ban, effective by the year 2000.\textsuperscript{39}

The German ministry of health issued similar advice and, in 1992, informed mercury amalgam manufacturers of its intention to ban amalgam production.\textsuperscript{40} The German government also published a pamphlet recommending that mercury fillings be avoided by individuals with kidney disease, children under the age of six, and all pregnant women.\textsuperscript{41} Recently, one manufacturer of dental amalgam in Germany completely terminated production of the product.\textsuperscript{42}

In April 1994, the U.S. Public Health Service (PHS) released an evaluation of mercury-containing dental amalgam that found the

\textsuperscript{35} Vimy, \textit{supra} note 5 (citing D. Wenstrup et al., \textit{Trace Element Imbalances in Isolated Subcellular Fractions of Alzheimer's Disease Brains}, 533 \textit{BRAIN RES.} 125, 125-31 (1990)).

\textsuperscript{36} Vimy, \textit{supra} note 5.

\textsuperscript{37} Id.

\textsuperscript{38} O'Mara, \textit{supra} note 16, at 32 (citing SAM ZIFF, \textit{THE TOXIC TIME BOMB}, 102 (Aurora Press 1994)).

\textsuperscript{39} Id.

\textsuperscript{40} Id.

\textsuperscript{41} Id.

\textsuperscript{42} Id.
amalgam has continuing value in maintaining oral health.\textsuperscript{43} According to the report, there is no solid evidence of any harm to the millions of Americans who have these fillings, and there is no persuasive reason to believe that avoiding amalgams or having them removed will have a beneficial effect on health.\textsuperscript{44} The report, however, did acknowledge that mercury exposure at high levels can produce poisoning symptoms.\textsuperscript{45} Although PHS states there have been only fifty confirmed cases of allergic reactions since 1900, they did acknowledge that there is no conclusive evidence that mercury vapor is harmless.\textsuperscript{46}

In response to the potential threat posed by amalgam fillings, the California legislature recently passed amendments to "Proposition 65" that requires consumer warnings to be posted in dental offices explaining that dental amalgam contains mercury, a chemical known to cause reproductive harm.\textsuperscript{47} In response to the amendments, amalgam manufacturers asked a federal district court to rule that the law was preempted by the Medical Device Amendments to the Federal Food, Drug, and Cosmetics Act.\textsuperscript{48} The district court ruled in favor of the amalgam manufacturers, but the decision was reversed by the Ninth Circuit Court of Appeals, which found the state requirements were not preempted by federal law because the Food and Drug Administration (FDA) had not promulgated any specific federal requirements for dental amalgam.

In an independent investigation of mercury amalgam, the United States Occupational Health and Safety Administration (OSHA) found that approximately 10 percent of all dental offices are severely contaminated by mercury since most have inadequate mercury decontamination systems.\textsuperscript{49} The results of a study presented to the Society of Toxicology in 1992 also showed reduced fertility in dental

\textsuperscript{43} See U.S. DEP'T OF HEALTH AND HUMAN SERVICES, supra note 4.
\textsuperscript{44} Id.
\textsuperscript{45} Id.
\textsuperscript{46} Id.
\textsuperscript{47} CAL. HEALTH & SAFETY § 25249.6 (1995) (making various technical and clarifying changes, and a legislative finding and declaration that the bill furthers the purposes of the Safe Drinking Water and Toxic Enforcement Act of 1986).
\textsuperscript{48} Committee of Dental Amalgam Mfrs. & Distrbs. v. Stratton, 92 F.3d 807 (9th Cir. 1996).
\textsuperscript{49} Taylor, supra note 1.
assistants who are occupationally exposed to mercury vapor from amalgam.\textsuperscript{50} The high incidence of suicide among dental professionals may also point to the "neurotoxic" effects of mercury accumulated in the brain.\textsuperscript{51}

In addition, it is significant that dentists have almost twice the concentration of mercury in their blood as non-dentists.\textsuperscript{52} Dentists encounter mercury through contact and handling of mercury-containing compounds, as well as inhalation of vapors during the preparation, handling, placement and polishing of the amalgam. Consequently, mercury contamination of dental offices may result from a variety of sources including:

1. accidental spills;
2. mercury stored in leaking containers;
3. contaminated mechanical amalgamator;
4. high temperature sterilization of mercury contaminated instruments; and
5. heating the amalgam.\textsuperscript{53}

Even though OSHA has set the threshold limit value of exposure to mercury vapor at 0.05 mg per meter of air for eight hours a day, forty hours per week,\textsuperscript{54} as many as 10 percent of dental offices have been shown to have mercury vapor concentration greater than 0.1 mg per cubic meter of air.\textsuperscript{55}

The occupational hazard from exposure to mercury vapor in dental offices can be reduced significantly by proper preventive measures. These measures include the:

\textsuperscript{50} Id.
\textsuperscript{51} Id.
(1) proper storage of mercury materials in unbreakable, tightly sealed containers;
(2) proper collection of globular particles of mercury;
(3) use of sealed capsules of amalgam;
(4) well ventilated working areas;
(5) use of commercial suppressants for mercury spills;
(6) avoidance of heating of mercury or amalgam;
(7) use of water spray and suction when grinding amalgam;
(8) monitoring of the concentration of mercury in the air;
(9) alerting all personnel involved in working with mercury;
(10) performing yearly blood mercury determination on all dental personnel.56

With proper precautions and good mercury hygiene, exposure to mercury vapor in the dental office need not pose a health hazard to dental professionals.

ALTERNATIVES TO MERCURY AMALGAM FILLINGS

In the face of potential dangers posed by mercury exposure from amalgam fillings, dental consumers must decide whether to risk exposure to mercury or to act on the side of caution and have some alternative substance placed in their mouths as fillings. Further, there is the more complicated question of whether to have existing mercury fillings replaced with alternative substances.

During the past decade, a growing number of American dentists have expressed concern over the use of mercury in fillings, but only about 3,000 of 150,000 dentists in the United States have stopped using amalgams entirely.57 In addition, several thousand dentists offer

57 Tom Monte, Fear and Loathing in the Dentist’s Chair; Nontoxic Alternatives to Mercury Fillings, 22 EAST WEST NATURAL HEALTH 65 n. 4 (1992).
alternatives to amalgams for patients who request them. The alternative filling substances include plastic composite, porcelain and gold. 58

The price of any dental filling varies depending on the number of tooth surfaces involved and the dentist chosen, but the average amalgam filling usually costs between $55 and $110. Gold fillings for a single tooth surface are more expensive and can range between $500 and $700, while a porcelain crown can cost as much as $800. Of all the materials available, gold lasts the longest and is also biocompatible, causing little if any harm to the body. 59

Another option for dental fillings are composite fillings, which contain a plastic resin and any variety of hard substances, like quartz crystal. The resin serves as the matrix, or binding material, that holds the quartz in place. 60 The average composite filling costs between $85 and $175. 61 In addition, many dentists are now curing, or baking, composite in a laboratory before installing the filling. Although the curing process generally costs an additional $50 in lab fees, it will make the filling more durable and extend its life. 62

Although some pro-amalgam dentists argue that composite fillings are not durable and break down long before amalgam fillings, research has shown that composites hold up well and offer almost as long a life as amalgam fillings which, according to the ADA, is approximately eight and one-half years. 63 In addition, most dental insurance companies will pay for replacement of fillings within three years of installation should it be required. 64

Finally, studies published in the Journal of the American Dental Association have demonstrated that after five years both amalgam and composite fillings show comparable wear and strength. According to some dentists who currently use composite fillings, if placed correctly the filling will stand up as well as an amalgam for at least seven years. 65

58 Id.
59 Id.
60 Id.
61 Id.
62 Id.
63 Id.
64 Id.
65 Id.
 Nonetheless, many new composites are being developed each year that are even stronger, and more durable.\textsuperscript{66}

The question of whether health improvements will result from the removal of amalgam fillings is a very controversial issue for the dental profession.\textsuperscript{67} The current position of the National Institute of Dental Research and the ADA, however, is there is insufficient evidence to warrant removal of amalgam restorations.\textsuperscript{68} In fact, a dentist who removes amalgam restorations for any reasons not documented through research can even be sued for fraudulently misrepresenting the need for therapy, and risks losing his or her license to practice dentistry.\textsuperscript{69}

\section*{ENVIRONMENTAL CONCERNS}

The greatest environmental impact from the practice of dentistry probably results from the mercury found in amalgam. Dentists worldwide consume 3 percent to 4 percent of all mercury produced\textsuperscript{70} and nationwide, the dental industry uses 100 tons of mercury per year.\textsuperscript{71} As a result, many communities throughout the country are becoming increasingly concerned about the purity of water supplies and the decreasing availability of landfills. Reduction of hazardous substances at the source is a mandate of the United States Environmental Protection Agency and is often the most cost-effective means of pollution control.\textsuperscript{72}

Most mercury generated by humans and released into the environment results from the combustion of fossil fuels and incineration

\begin{itemize}
\item\textsuperscript{66} Id.
\item\textsuperscript{67} H. Huggins, \textit{Mercury: A Factor in Mental Disease?}, 11 J. ORTHO. PSYCH. 3, 3-16 (1932).
\item\textsuperscript{68} \textit{AMERICAN DENTAL ASS’N, DIVISIONS OF COMMUNICATION AND SCIENTIFIC AFFAIRS, Special Report: When Your Patients Ask About the Mercury in Amalgam, 120 J. AM. DENT. ASS’N 935, 935-938 (Jan. 7, 1990).}
\item\textsuperscript{69} Christina Gorman, \textit{A Colorado Dentist Built a Successful Practice Pulling Out Silver Fillings, Now He’s In Trouble}, \textit{TIME}, Dec. 11, 1995, at 71; Board of Dental Examiners v. Hufford, 461 N.W.2d 194 (Iowa 1990).
\item\textsuperscript{70} North Carolina Office of Waste Reduction, \textit{FACTSHEET, Dental Waste Management} (March 1996).
\item\textsuperscript{71} Taylor, \textit{supra} note 1.
\end{itemize}
of municipal and medical waste. In fact, dentists remain one of the last direct contributors of mercury to surface waters. Because of its mercury content, dental amalgam waste is considered a hazardous substance and its disposal is subject to environmental limits set by federal, state and local governments. This regulatory authority derives from the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 and the Resource Conservation and Recovery Act (RCRA). The RCRA was enacted in 1976 to "promote the protection of human health and environment, and to conserve valuable material and energy resources." The federal law also grants states and local governments the authority to implement their own regulations for industrial wastewater treatment programs.

Wastewater treatment plants are also required to comply with federal and state standards for water quality by obtaining discharge permits before releasing any wastewater directly into receiving surface waters, such as rivers and streams. The discharge permit, known as the National Pollution Discharge Elimination System Permit, establishes specific legal limits on the amount of certain pollutants that may be discharged to receiving waters by treatment facilities. An example of this is Detroit's National Pollution Discharge Elimination System permit that has established a limit for mercury and other pollutants. In addition, the Detroit Water and Sewerage Department was required to establish and implement a mercury minimization program to control and reduce the amount of mercury that enters the sewer system for processing and removal.

Most dentists today purchase mercury as part of an encapsulated package containing other amalgam materials. Despite efforts to prepare only the amount of amalgam needed, dentists generally use only about 45 percent of the original triturated materials in the final restoration or

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73 See Monte, supra note 57.
77 Id.
78 Id.
The remaining amalgam scrap is typically composed of small chunks of amalgam material, a slurry of grindings of extremely small particles, water, and saliva. The scrap is removed from the patient's mouth with a chairside suction or vacuum device that is powered by a vacuum pump located in a more remote part of the office or building. A mixture of the amalgam waste, containing mercury, water, saliva, and other debris, travels through pipes and tubing to the vacuum pump, where it is eventually discharged into the wastewater line that leads to the municipal sewer system. In some offices, the air and liquid portions of the evacuant are separated in an air/water separator tank. The liquid and solid materials are drained into the wastewater while the air is vented elsewhere, usually to the outside of the building. Questions have been raised about the ultimate fate of this amalgam waste and the possible environmental impact of its contents, particularly mercury.

Once in the vacuum system, the major amalgam particles settle out in the plumbing or are trapped in the screens protecting the vacuum pump. Particles smaller than the filter hole size are normally lost to the sewer unless the dentist has a high efficiency filtration or separation device in place. Some of the mercury in trapped or discharged amalgam also dissolves into the wastewater because of the increased surface area of the smaller particles and the nature and pH of the wastewater. Now, more than ever, dentists are being encouraged to recycle all amalgam particles trapped on screens or in traps.

In recent years, many cities throughout the United States have tested the wastewater from dental offices for mercury levels. One reason for such increased scrutiny of dental mercury discharge is the overall reduction in mercury usage by other industrial, commercial and residential sources. The United States has experienced an overall drop in mercury usage of 74 percent from 1980 to 1993. Studies conducted

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80 Id.
81 Id.
82 Id.
83 See Hughes, supra note 76.
84 Id.
in Duluth, San Francisco, Detroit and Seattle indicate that dentists are responsible for up to 50 percent of mercury in municipal wastewater. In fact, a dental survey conducted by the Detroit Water and Sewerage Department revealed that only 12 percent of respondents used raw mercury in the office and that 88 percent of respondents used pre-capsulated amalgam. In addition, it is estimated that while 27 percent of old amalgam restorations removed are lost to the sewer system, 80.45 percent of respondents do recycle their silver/mercury amalgam.

Waste amalgam is regulated as both a solid waste and as a wastewater contaminant. Solid amalgam is regulated as a hazardous waste, because Toxicity Characteristic Leaching Procedure (TCLP) tests have shown that it exhibits characteristic toxicity for mercury. Facilities that produce less than 220 pounds total of hazardous waste in any one month are classified as “Conditionally Exempt Small Quantity Generators.” Most dental facilities would fall into this category, which is exempt from most federal Resource Conservation and Recovery Act requirements. Although exempt from federal law, states may impose more stringent requirements on hazardous waste generators.

In California, for example, if a waste is determined not to be regulated by the United States Environmental Protection Agency, a generator must still determine if the waste is regulated by the state Department of Toxic Substances Control. If so, the waste is considered a hazardous waste under the state law and its disposal is regulated by the state agency.

Another example is the state of North Carolina, which prohibits disposal of hazardous waste, even from conditionally exempt small quantity generators, into solid waste landfills. Thus, waste amalgam

87 Id.
caught in the traps and screens of the plumbing as well as other scraps of amalgam from the dental office, must be shipped to a properly permitted facility. The tricurating amalgam capsules normally pass the TCLP test and can be disposed as general solid waste.

Ultimately, if no action is taken, mercury will continue to flow from dental offices into the nations' sewerage system. In areas with growing populations, the amount of amalgams both placed and removed will likely increase. This increase can be offset, however, by decreasing amalgam use. And if the placement of new amalgams continue to decrease, complete removal of existing amalgams would occur in approximately ten to twenty years following placement. In addition, as more concerns about the use of amalgam arise, patients may also choose to have amalgams removed, causing a temporary increase in the mercury levels of the sewerage system but reducing the overall amount of amalgam filling in use.

Land fills containing mercury waste pose a potential long-term hazardous waste liability to dentists. In Seattle, for example, the King County Public Health Department controls the approval of wastes going to landfills and the Department's permission must be obtained before discarding potentially hazardous substances into the garbage. No amalgam waste from evacuation system traps may be incinerated with infectious waste because mercury volatilizes and is then discharged into the atmosphere. The best choice, therefore, from an environmental standpoint and the standpoint of the business operator, is recycling and reclamation of the amalgam.

As generators of hazardous waste, dentists have a "cradle to grave" responsibility for that waste, even after it is taken by another company for recovery or disposal. With the expanded scope of liability under the Federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), all generators of hazardous waste should be concerned if they want to avoid potential liability. In 1980, Congress considered and enacted CERCLA in an effort to abate and control the

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91 See American Dental Ass'n, supra note 68.
92 See Welland, supra note 79.
93 Id.
problems associated with hazardous substance disposal sites, and to impose the costs of cleanup on the parties responsible for releasing the hazardous substances.  

**RECYCLING AS AN ALTERNATIVE MEANS OF DISPOSAL**

A survey of dentists from the Seattle area has revealed that nearly 80 percent of dentists have a high degree of concern for the environment. Recycling practices, in which more than 50 percent of dentists participate, are quite good for lead foil, amalgam waste and gold. The number of dentists recycling these materials could only increase if information on where and how to recycle metals is provided.

Many state dental associations are now encouraging dentists to recycle mercury amalgam waste through companies that provide this service. Many of these companies will pay for the amalgam if the quantity is sufficient, or will accept the material free of charge. Because it is a hazardous material, collected amalgam is surcharged (usually less than $10) by most express courier companies. All recycling companies will accept both material that has contacted patient body fluids and noncontact material, but some companies have special packing requirements such as separation of contact and noncontact material, sterilization, or drying prior to shipment.

The Detroit Water and Sewerage Department, for example, is now offering a Bulk Mercury Collection Program in cooperation with the Michigan Dental Association, National Wildlife Federation, and state and federal agencies. This one time, six-month pilot program is targeted to dentists throughout Michigan and will provide proper disposal of raw mercury from area dental offices at no cost.

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96 See Welland, supra note 79.
97 Id.
98 Id.
99 Detroit Water and Sewerage Department Coordinates Mercury Collection Program, PR Newswire, Jan. 26, 1996. All invoices and records of amalgam shipments be saved. The sender should record the date of the shipment, the quantity shipped, and the destination (the recycler's address).
Additional waste management companies and recyclers are also needed and should be licensed to retrieve waste materials at the office, and be required to properly manage the waste materials. Many companies will even provide dentists with receipts and tracking documentation verifying proper management, recovery, or disposal of waste. For example, Amalgaway, a mail-in mercury recycler in Indiana, in addition to providing documentation to support the chain-of-custody of the amalgam waste, will actually indemnify dental offices from liability for their mercury disposal.

CONCLUSION

In light of the continued concern about dental amalgam use, more research is needed to contend with unanswered questions about its safety. Additional scientific studies are required to examine the correlation between dental amalgam and the development of various health problems. Current evidence indicates that when reasonable precautions are used, the mercury in dental amalgam is not a significant health hazard to most dental personnel and patients. However, for the small percentage of persons and patients with hypersensitivity to mercury, there is a potential risk in the use of amalgam. In such cases, the use of alternative materials should be considered.

Dentists who continue to use mercury amalgam are now faced with the introduction and enforcement of federal, state and local requirements regulating the disposal and use of mercury amalgam as a hazardous substance. Studies examining the contamination of municipal sewage systems from dental wastewater show that dental offices contribute to the pollution of our rivers, lakes and streams. Many local and state governments are encouraging the proper disposal of mercury to protect

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101 For further information on dental amalgam recycling, Amalgaway can be directly contacted at 1002 West Tray Avenue, Indianapolis, IN 46225, or by calling 1.800.267.1467.
the environment from mercury overexposure through targeted legislation. Private industry has also recognized the market for mercury recycling and companies are emerging that will pick-up dental amalgam or receive it by mail, while indemnifying the dentist from liability under environmental laws.

More conclusive research is needed to fully comprehend the danger of amalgam fillings. Recent studies indicate that government regulation of the amount of amalgam waste generated by dental offices seems warranted and has created a new market for amalgam recyclers. Therefore, until more conclusive evidence is established, it is unlikely that the ADA or the U.S. government will go to the same extreme as some other countries by outlawing the use of mercury in amalgam.