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Summary of Recent Study of Dental Amalgam in Wastewater

Prepared by the American Dental Association

Mercury in surface waters is a topic gaining much attention. The primary source of mercury in surface waters is air deposition. Nevertheless, in some areas, there is increased regulatory pressure to control mercury in wastewater discharged to surface waters. When this occurs, estimates of the environmental contribution of mercury from dental office wastewater (in the form of dental amalgam, a stable alloy of silver, tin, copper, zinc and elemental mercury) may need to be considered. As a result, it is important that scientifically sound numbers be developed to identify the actual and relative contributions of mercury from dental office wastewater. Further, an assessment of the actual amount of dental amalgam captured by various dental office controls is needed.

The American Dental Association commissioned a scientific assessment of these and other questions. The assessment was submitted to various EPA officials, the Association of Metropolitan Sewerage Agencies (AMSA), and other reviewers. The basic conclusions of the assessment are consistent with other studies cited in the assessment. This assessment titled, "An assessment of mercury in the form of amalgam in dental wastewater in the United States" is published in the peer-reviewed journal, *Water, Air and Soil Pollution.*[1]

Amalgam particle waste is generated during placement or removal of amalgam restorations. Most of the amalgam waste discharged in dental office wastewater is in the form of particles. A scientific assessment was recently conducted to estimate the amount of amalgam waste in wastewater, how much of it reaches wastewater treatment plants, and how much of it is discharged by the treatment plants to surface waters. A summary of the results of this assessment follows.

Measuring the exact amount of amalgam waste being generated and discharged from a dental office is a very difficult task. The discharge of amalgam waste into sewerage systems is complicated by the fact that this waste is generated on an intermittent basis with huge day-to-day and even minute-to-minute variations. Methods such as sampling from drain or sewer lines, or even collecting total waste over several days show huge variations that are difficult to extrapolate into total waste generated over a year. For these

[1] Vandeven JA. McGinnis SL. An Assessment of Mercury in the Form of Amalgam in Dental Wastewater in the United States. Water Air & Soil Pollution. 2005 June;164(1-4):349-66.

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reasons, sampling dental office wastewater discharge does not provide either an accurate or reliable estimate of discharge.

One common engineering method employed in environmental science to overcome this limitation is the mass balance approach. This method uses existing data on the total amount of amalgam used, the known performance of existing capture devices, and the types and proportions of waste generated when placing and removing amalgam restorations to determine how much and where this waste is either being captured or discharged. The mass balance assessment tracks the total amount of amalgam used and removed from the dental office source, all the way through the waste processing and collection system, to determine both where the amalgam waste ends up and how much is captured at each part of the process.

In a mass balance assessment of the annual amount of amalgam discharged in dental wastewater nationally in 2001, it was estimated that 29.7 tons of mercury in the form of amalgam was discharged into dental units by dental offices. Chair-side traps in dental units and vacuum pump filters captured 78% (23.2 tons) of the mercury in the form of amalgam. Approximately 6.5 tons of mercury in the form of amalgam discharged from dental offices was determined to have reached the wastewater treatment plants, which captured 6.2 tons (95%) of this discharge. The remaining 0.3 tons was discharged as effluent to surface waters.

Of the 6.2 tons of mercury (in the form of amalgam) captured by wastewater treatment plants nationally, 1.6 tons was disposed of in the form of filter grit solids and 4.6 tons ended up in treatment plant biosolids. Approximately 1 ton of the biosolids was incinerated nationwide, with the incinerator emission controls capturing 0.8 tons of the mercury. This resulted in 0.2 tons of mercury being emitted to the atmosphere. Of this atmospheric emission, approximately 0.1 ton was deposited in the United States, (based on an EPA estimate that one third of the atmospheric mercury generated in the United States is eventually deposited in this country). Thus, based on this mass balance assessment, a total of 0.4 tons (0.3 tons from wastewater treatment plant effluent and 0.1 ton from air deposition) of mercury entering surface waters in the United States could be attributed to dental office discharge.

It is important to put this number in context. In the 1997 EPA Mercury Study Report to Congress, it was estimated the mercury emission in the United States is 158 tons annually. Thus an estimated 52.6 tons is deposited, based on the EPA estimate that one third of the mercury emission is deposited in this country. By comparison, the 0.4 tons from amalgam waste entering surface waters is 0.76% of the estimated deposit for all mercury emission in the United States.

It is also useful to assess the additional amount of dental amalgam likely to be captured through the use of ISO-compliant amalgam separators, and at what cost. The assessment[1] addresses both of these points. The use of ISO-compliant amalgam separators (95% amalgam removal efficiency) would reduce the estimated discharge of mercury in the form of amalgam to wastewater treatment plants to 0.3 tons. Due to the size distribution of amalgam particles, this form of mercury in the form of dental amalgam is unlikely to be captured by the wastewater treatment plant and would be discharged in the effluent. In other words, the use of separators is unlikely to have any material impact on mercury in treatment plant effluent—the amount so discharged, with or without separators, is approximately 0.3 tons. The use of amalgam separators, however, would likely result in the virtual elimination of the deposition of 0.1 ton of mercury from the incineration of amalgam in biosolids.

With an estimated annual cost of $76 million to $114 million for the purchase, installation and maintenance of amalgam separators in dental offices in the United States, the annual cost of removing 1 ton of mercury through amalgam separators is estimated to be $760 million to $1.14 billion. Even if the use of amalgam separators could reduce the mercury in wastewater treatment plant effluent by 29% (an unlikely result) resulting in 0.2 tons of mercury discharged to surface waters, the annual cost of removing 1 ton of mercury is estimated to be $380 million to $570 million.

The American Dental Association has published a set of recommended Best Management Practices for Waste Amalgam. These BMPs have been widely distributed, in a variety of formats, to dentists throughout the country. Compliance with the BMPs will result in substantial reductions of dental amalgam in dental office wastewater, without the extraordinary costs of mandatory separators. The BMPs are available on www.ada.org/goto/amalgambmp. For more information contact the ADA's Division of Science at 312/440-2878 or science@ada.org.

Numerical Summary

Mercury in the form of amalgam discharged into dental units: 29.7 tons

Mercury in the form of amalgam captured by chair-side traps and vacuum pump filters: 23.2 tons

Mercury in the form of amalgam reaching publicly owned
treatment works (POTWs): 6.5 tons

Mercury in the form of amalgam captured by POTWs in grit solids and biosolids: 6.2 tons

Mercury in the form of amalgam discharged as effluent from POTWs to surface waters: 0.3 ton

Mercury in the form of amalgam in POTW biosolids: 4.6 tons

Mercury in the form of amalgam in POTW biosolids incinerated: 1.0 ton

Mercury from amalgam captured by incinerator emission controls: 0.8 ton

Mercury from amalgam emitted to the atmosphere from incineration of POTW biosolids: 0.2 ton

Mercury from incinerated amalgam deposited onto US surface waters: 0.1 ton

Total mercury in surface water attributable to amalgam in dental office wastewater: 0.4 ton

Number of dental offices to install amalgam separators: 95,066

Cost of purchase, installation and maintenance of amalgam separators: $76 million-$1.14 billion

Mercury in the form of amalgam reaching POTW after installation of amalgam separators: 0.3 tons

Mercury in the form of amalgam discharged as effluent from POTWs to surface waters after installation of amalgam separators: 0.3 ton

Mercury from incinerated amalgam deposited onto US surface waters after installation of amalgam separators: 0 ton

Total mercury in surface water attributable to amalgam in dental office wastewater: 0.3 ton

Reduction of mercury in surface waters attributable to amalgam in dental office wastewater after installation of amalgam separators: 0.1 ton

Cost of removing 1 ton of mercury through amalgam separators: $760 million-$1.14 billion

Cost of removing 1 ton of mercury through amalgam separators assuming 29% reduction of mercury in POTW effluent: $380 million -$570 million