



# The Minamata Convention on Mercury: Attempting to address the global controversy of dental amalgam use and mercury waste disposal



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## HIGHLIGHTS

- The Minamata Convention on Mercury is a new global health and environment treaty.
- The Convention calls for a phase down of dental fillings using mercury amalgam.
- It includes voluntary measures but fails to establish binding targets on a phase down.
- Future review should include exploration of ways to strengthen implementation.
- Strengthening the Convention ensures oral health access and environmental stewardship.

## ARTICLE INFO

### Article history:

Received 29 August 2013

Received in revised form 28 October 2013

Accepted 29 October 2013

Available online 27 November 2013

### Keywords:

Minamata Convention on Mercury  
Mercury Global Environmental Programme  
Global oral health  
Mercury pollution  
Global health  
Dental amalgam

## ABSTRACT

In October 2013, a new international binding treaty instrument called the Minamata Convention on Mercury opened for signature in Minamata City, Japan, the site of arguably the worst public health and environmental disaster involving mercury contamination. The treaty aims to curb the significant health and environmental impacts of mercury pollution and includes provisions addressing the mining, export and import, storage, and waste management of products containing mercury. Importantly, a provision heavily negotiated in the treaty addresses the use of dental fillings using mercury amalgam, an issue that has been subject to decades of global controversy. Though use of dental amalgam is widespread and has benefits, concerns have been raised regarding the potential for human health risk and environmental damage from emissions and improper waste management. While the Minamata Convention attempts to address these issues by calling for a voluntary phase-down of dental amalgam use and commitment to other measures, it falls short by failing to require binding and measurable targets to achieve these goals. In response, the international community should begin exploring ways to strengthen the implementation of the dental amalgam treaty provisions by establishing binding phase-down targets and milestones as well as exploring financing mechanisms to support treaty measures. Through strengthening of the Convention, stakeholders can ensure equitable access to global oral health treatment while also promoting responsible environmental stewardship.

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## 1. Introduction

The global debate regarding the environmental and health impact of dental amalgam containing mercury (Hg) is rapidly moving toward consensus with the recent adoption by 139 countries of an international binding treaty instrument (UNEP, 2013c), the United Nations Environment Programme (“UNEP”) Minamata Convention on Mercury (“Minamata Convention”) (Environmental Health Department,

2002). This Convention could have a lasting impact on the future of global oral health.

Dental amalgam – a dental restorative filling material alloy that consists of approximately 50% mercury with the balance including silver, tin, copper, and zinc and other trace metals – has been used for centuries by dentists globally to restore teeth diseased by dental caries (FDA, 2009b; Bharti et al., 2010). Its use in dental amalgam represents the most common form of human exposure to elemental mercury (recognized as a toxic substance) and along with its use in laboratory/medical devices, comprises 53% of total global mercury emissions leading to potential environmental damage (WHO, 2005). Despite ongoing concerns about human health effects, the use of dental amalgam containing mercury continues to be widespread given its potential benefits

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and cost-effectiveness, though in some regions it is showing declines in use (Bharti et al., 2010). With the vast majority of the world's population afflicted by dental caries, the importance of ensuring adequate and safe access to oral health treatment options has made this an important global public health issue (British Dental Journal, 2004; WHO, 2004).

Advocates of using dental amalgam as a dental restorative material cite its low cost, ease of manipulation and placement, durability, and historical record of safety (Bharti et al., 2010; Rathore et al., 2012; Dodes, 2001). Opponents point to its unattractive appearance, potential to weaken tooth structure, release of mercury vapor and particles, potential occupational harm to dental staff, growing availability of alternative composite fillings, and negative environmental impact from waste disposal (Mutter, 2011; Hörsted-Bindslev, 2004; Mutter et al., 2005; WHO, 2005). Consequentially, ongoing controversy regarding continued use of dental amalgam containing mercury has primarily focused on two distinct but related issues: the potential human health impact from mercury exposure and the environmental impact of medical mercury-related waste.

Below, we examine the current international debate and potential future use of mercury in dental amalgam. We discuss ongoing human health and environmental concerns and provide policy analysis of the Minamata Convention in response to these issues. Based on these analyses, we then formulate suggestions on how the Convention could be strengthened and better implemented to promote global oral health and ensure environmental stewardship.

### 1.1. Global dental amalgam controversy

A primary but unresolved concern of dental amalgam use is its potential impact on population-based health given its widespread use in dentistry. From the perspective of patient safety, it is largely undisputed that intraoral amalgam fillings lead to continuous vapor exposure from elemental/inorganic mercury, an element that is recognized for its toxicity and has been associated with a number of adverse health outcomes (including neurological and renal effects) primarily observed in occupational settings (Richardson et al., 2011; Bernhoft, 2012; Park and Zheng, 2012; Mutter et al., 2005).

Yet the amount/dose of mercury exposure occurring from dental amalgam use and its consequential health impact remains in sharp dispute, with absorption rates also shown to vary based on individual behavior (e.g., chewing, brushing, bruxism) as well as other factors (Richardson et al., 2011; WHO, 2003). Though studies have shown a positive correlation between the number of dental amalgam restoration surfaces and the levels of mercury in human blood, tissue, and urine, whether such exposure equates to significant negative health risk is still under debate and requires further study (FDA, 2009a; Nylander et al., 1987).

From an environmental perspective, methylmercury has been globally recognized as an environmental toxin by organizations including the UNEP, the World Health Organization ("WHO"), the International Labour Organization, and the US Environmental Protection Agency. Specifically, mercury medical-related waste occurring from extracting, disposing and incineration of dental amalgam and from human cremation has been found to contaminate the atmosphere, land, water sources, and waste-water (WHO, 2005; Hörsted-Bindslev, 2004). Yet, sovereign responses to dental-related mercury environmental contamination have been uneven and are largely influenced by varying national or local regulations on medical waste disposal, particularly with the absence of an international binding agreement (Spencer, 2000). For example, countries including Norway and Denmark have banned the use of mercury in dental amalgam over concerns of environmental impact, with Sweden joining this ban on the grounds of both environmental and health concerns (Richardson et al., 2011; Reuters, 2008; Lynch and Wilson, 2013). Other countries, such as the USA, may lack national legislation on dental mercury disposal, but may have

local or state regulations (e.g., New York State) that require specific disposal and recycling requirements (New York State Department of Environmental Conservation, n.d.).

Similarly, professional dental societies have issued their own policy statements regarding the use of dental amalgam containing mercury in an effort to influence international negotiations on the Minamata Convention. The World Dental Federation ("FDI"), a non-governmental organization with approximately 200 national member associations and specialist groups from more than 130 countries representing over 1 million dentists worldwide, has come out in favor of amalgam as a safe and effective restorative material, only calling for a gradual reduction (FDI, 2013b). Joining FDI's policy stance was also the American Dental Association ("ADA"), the largest and oldest dental organization in the USA representing some 157,000 members. The ADA's official position is that dental amalgam is affordable, durable, and possesses a long record of safety and effectiveness (ADA, n.d.). In contrast, other smaller advocacy groups, such as the World Alliance for Mercury-Free Dentistry and the International Academy of Oral Medicine and Toxicology, have favored a ban on dental amalgam and also participated in treaty discussions advocating for this position (IISD, 2013).

These conflicting perceptions, positions, and policies addressing the health and environmental impacts of dental amalgam that vary by country and stakeholder, have led to an ongoing global "amalgam controversy" with some stakeholders advocating for its continued unrestricted use, and others calling for a complete global ban (Rathore et al., 2012; Richardson et al., 2011; Bharti et al., 2010). Yet for middle and low income countries that increasingly face challenges in dental treatment capacity and availability of resources, a complete ban on mercury amalgam or switch to more costly composite materials may not be currently feasible (WHO, 2009). Due in large part to this concern, international organizations such as the WHO have suggested a "phasing down" strategy to bring a more gradual approach to addressing the diverse public health, environmental, and economic concerns of mercury dental amalgam (WHO, 2009; Harrison, 2011).

## 2. The Minamata Convention

Ongoing debate regarding the future use of dental amalgam in global oral healthcare and exploring a phase-down strategy has been the subject of international public health and environmental discussions. In 2009, the governing council of the UNEP requested the formation of an Intergovernmental Negotiating Committee to examine ways to reduce the risk to human health and to the environment from the use and release of mercury, including in dental amalgam (UNEP, 2009). This process concluded in January 2013, with national governments agreeing to the text of the Minamata Convention during the 5th session of the committee, and the recent opening of the treaty for signature in October 2013 (UNEP, 2013c). As of early November 2013, 93 countries have become signatories to the treaty and one country, the United States, has ratified. The Minamata Convention will come into force after 50 countries have ratified (UN News Centre, 2013).

The Minamata Convention was named after the neurological syndrome caused by severe mercury poisoning from consumption of contaminated seafood known as "Minamata disease". The disease was first identified in Minamata City, Japan in 1956, where mercury contamination released through industrial waste water led to a public health disaster resulting in thousands of deaths as well as a congenital form of the disease (Tsuda et al., 2009). Included in the treaty are a number of controls regarding mercury mining, import and export, storage, disposal, and reducing mercury emissions (UNEP, 2013b). The treaty also includes commitments to health promotion and education, healthcare capacity building, technical assistance, and technology transfer with special consideration for least developed countries (UNEP, 2013b). The most powerful provisions of the treaty are the institution of a global ban on the import and export of certain products containing mercury (including batteries, switches/relays, fluorescent lamps, soaps/

cosmetics) set to commence in 2020 (UNEP, 2013b). However, exempted from the 2020 ban are dental amalgam fillings using mercury (UNEP, 2013b).

Instead, Article 4, Paragraph 3, Part II: Products subject to Article 4, Paragraph 3, of the Minamata Convention specifically addresses dental amalgam by calling on countries that sign and eventually ratify the Convention to phase-down the use of dental amalgam taking into account their own “domestic circumstances and relevant international guidance” and generally committing to two or more measures outlined in the treaty (UNEP, 2013b). These include:

- (i) Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration;
- (ii) Setting national objectives aiming at minimizing its use;
- (iii) Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;
- (iv) Promoting research and development of quality mercury-free materials for dental restoration;
- (v) Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices;
- (vi) Discouraging insurance policies, and programs that favor dental amalgam use over mercury-free dental restoration;
- (vii) Encouraging insurance policies and programs that favor the use of quality alternatives to dental amalgam for dental restoration;
- (viii) Restricting the use of dental amalgam to its encapsulated form;
- (ix) Promoting the use of best environment practices in dental facilities to reduce releases of mercury and mercury compounds to water and land.

The measures agreed upon represent the culmination of 4 years of negotiations on this controversial issue. During this time, some country representatives called instead for a strengthening of restrictions on dental amalgam with other policy alternatives including: 1 – proposing a binding phasing out by 2025 with polluters bearing the cost of disposal and management; and 2 – a complete ban given availability of other alternatives (UNEP, 2013a). Ultimately, countries agreed to the language contained in the negotiated treaty draft. However, upon more detailed examination, these text and alternatives therein are generally non-binding, have no specified time frame for phasing-down use, and only require voluntary commitment on 2 out of 9 total recommended measures.

In response to conclusion of the treaty discussions, dental stakeholders such as the FDI and the ADA that lobbied against a binding phase-down announced their support of the final negotiated Minamata Convention provisions. Specifically, FDI has called for support of a general phase-down approach based on prevention, research for alternative materials, and waste management practices (FDI, 2013a). The ADA also supports the treaty based on the ADA's position of the overall safety of dental amalgam and that continued amalgam use will not be subject to any binding restrictions under the Convention (ADA, 2013).

### 3. Strengthening the Minamata Convention

The Minamata Convention has many positive elements supported by dental associations that have the potential to improve global oral health and address the environmental impact of mercury-related disposal. These include strengthening oral health through national prevention programs, investment in research & development for alternative materials, development of economic incentives for use of alternatives, promotion of environmental waste and disposal controls, and training and education of dental health professionals. However, the absence of binding and measurable requirements may pose challenges in effectively implementing the intent of the treaty and ensuring harmonized environmentally-sound management.

Specifically, lack of a binding phase-down date with quantifiable targets for reduction of mercury-based dental amalgam use makes the provision virtually impossible to enforce even if a party signs on and ratifies the treaty. Additionally, permissive language allowing countries to defer to their own “domestic circumstances” provides a broad exclusion that will undoubtedly lead to countries deprioritizing any commitments under the treaty due to potential domestic pressures that may be politically and/or economically focused rather than public health or environmentally-based. Further, countries may selectively pick and choose low resource/low impact measures or may simply point to measures already implemented as fulfilling treaty measures to minimize further commitments and resource allocation. As an example, only Sub-sections (v) and (ix) of the treaty provision specifically addresses waste and environmental-related controls for dental amalgam use and management, despite the fact that these measures are the primary purpose of the treaty.

Perhaps most importantly, there appears to be no specific funding mechanism to support the amalgam treaty measures and national programs recommended by it. Though pre-ratification activities of the treaty are generally supported by the Global Environment Facility, there does not appear to be a clear pathway for a sustainable funding mechanism specific to dental amalgam provisions (GEF, 2013). This would make it difficult to incentivize the development of alternative materials/reimbursement mechanisms or implementation of occupational health standards and waste management processes, especially for low-income countries and may provide a disincentive for phasing-down. Instead, a more dynamic global health policy solution to strengthen implementation of the Convention should be explored that takes into account the need for some measurable phase-down of mercury amalgam use given its clear environmental impact while also recognizing the need to ensure continued access to this form of dental treatment to those patients where no feasible alternative is available (Table 1).

Such a solution should include a tiered phase-down on mercury amalgam use. This approach can be based upon a country's oral health disease burden, income group, and dental treatment capacity, with poorer countries allowed more long-term phase-down periods compared to richer industrialized countries. This would be similar to provisions contained in the World Trade Organization Trade Related Aspects of Intellectual Property Rights Agreement, that have permitted least developed countries time extensions to implement treaty-bound obligations for global intellectual property rights (Mackey and Liang, 2012b). Any phase-down period should also include tangible milestones, including quantifiable reductions in mercury emissions, possible national adoption of use of amalgam separators, implementation of dental protocols for safe amalgam removal and disposal, and development of all party-transition task groups or public-private partnerships for amalgam waste management such as the UNEP-WHO-FDI-International Dental Manufacturers initiative that is being piloted in Africa (FDI, 2013c; Lynch and Wilson, 2013).

Using the tiered programmatic approach, financing mechanisms could be put in place so that “excess” polluters within a country, using the tiered treaty standard, that fail to meet their respective targets would pay penalties to their national governments for non-compliance. Countries could then earmark these funds for investment in the measures set forth in the Convention, including promoting preventive care national oral health programs, a mechanism similar to that suggested in the literature for the Nagoya Protocol on biodiversity and bioprospecting (Mackey and Liang, 2012a). A portion of these funds could also be allocated to a centralized fund administered by the UNEP and the Convention's Conference of Parties (“COP”) in support of Convention goals, including actively engaging in capacity building for oral health and environmental waste management in countries that lack adequate resources.

This policy proposal could be considered at the 5 year implementation review by the COP, which allows for amendment of the provision for dental amalgam contained in Annex A, Part II of the Convention,

**Table 1**  
Policy proposals to strengthen Minamata Convention.

| Proposal                                    | Description   | Benefits   | Existing models   |
|---|---|--|---|
| Tiered phase down on amalgam use            | Require tiered phase down period and targets on amalgam use based on a country's dental disease burden, dental treatment capacity, and income group.  | Richer countries with resources would be incentivized/required to pursue phase down for environmental benefits. Resource-poor countries would have adequate time/ extensions to implement phase down.        | Extensions for implementation to WTO TRIPS Agreement obligations for least developing countries. <sup>a</sup>                                   |
| Establish milestones for phase down period  | Development of international guidelines on potential tangible outputs for the phase down period with estimated timeline. These could include use of amalgam separators, development of dental protocols, and development of PPPs. | Would provide guidance to national governments on activities that would meet requirements of phase down and also provide tentative timelines for possible completion.  | Milestone payments are often used in drug discovery collaboration models. PPPs are common in global public health. <sup>b</sup>                 |
| Financing mechanism based on non-compliance | Financing mechanism requiring polluters to pay national governments for failure to meet phase down targets. Funds would be used to invest and implement for Convention Annex A measures and could be earmarked for UNEP/COP use.  | Would establish funding mechanism based on continued violation administered by national governments and shared with global system. Would enable capacity building and incentivize polluters to meet targets. | A similar policy proposal has been suggested in the literature for the Nagoya Protocol to address biodiversity and bioprospecting. <sup>c</sup> |

<sup>a</sup> Mackey TK, Liang BA. Promoting global health: utilizing WHO to integrate public health, innovation and intellectual property. *Drug Discov. Today* 2012; 17:1254–7.

<sup>b</sup> Nwaka S, Ridley RG. Virtual drug discovery and development of neglected diseases through public–private partnerships. *Nat Rev Drug Discov.* 2003; 2:919–28.

<sup>c</sup> Mackey TK, Liang BA. Integrating biodiversity management and indigenous biopiracy protection to promote environmental justice and global health. *American Journal of Public Health* 2012a; 102:1091–5.

taking into account additional research on the health and environmental impacts of dental amalgam and availability of alternative dental materials (UNEP, 2013b). If at that time tangible efforts toward mercury emission reductions from dental amalgam use have been achieved, then these recommendations can be implemented as guidance under the treaty as well as serve as important case studies for implementation lessons for other similarly situated countries. If efforts have not been adequately pursued, then binding targets and requiring countries to meet tangible outputs for the measures such as those suggested should be explored, and analyses of failure modes should also be engaged for future efforts at treaty implementation.

#### 4. Conclusion

The adoption, opening for signature and ratification of the Minamata Convention represents important international recognition of the potential dual harms of using mercury dental amalgam from a human health and environmental perspective. Yet, the use of dental amalgam will invariably continue as the need to provide access to equitable and affordable oral healthcare has never been greater. This necessitates a measured approach to a global dental amalgam phase-down under the new treaty. This can be accomplished by starting discussions on how to dynamically strengthen implementation of the Minamata Convention in order to ensure safe and environmentally-sound global oral healthcare that can finally begin to bring resolution to the debate over dental amalgam.

#### Conflicts of interest declaration and funding source statement

All authors declare that they have had no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; and no other relationships or activities that could appear to have influenced the submitted work. In addition, no third party has prompted any of the authors to write this article; and no additional author/professional writer contributed to the article. These were no funding sources for this manuscript.

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