EUROPEAN ENVIRONMENTAL BUREAU

World Alliance for Mercury-Free Dentistry
Alliance Mondiale pour une dentisterie sans mercure
Всемирный альянс за стоматологию без ртути
Alianza Mundial por una Odontología Sin Mercurio
التحالف العالمي لطب أسنان خال من الزئبق
世界无汞牙科联盟

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Technical Advantages of Mercury-Free Dentistry

1. Mercury-free fillings are more minimally-invasive than amalgam

It is well-established that amalgam damages healthy tooth tissue, weakens tooth structure, and fractures teeth:

- SCENIHR explains that "It is with respect to their aesthetics and non-adhesive character, which means that larger cavities have to be prepared, often with excessive tooth tissue removal, that amalgams may be seen to be inferior to the alternatives…"[1]

- Lynch *et. al*, note that "some significant disadvantages are associated with amalgam that are not encountered with resin based composite. These include…strict preparation requirements for depth and mechanical retention; and its non-adhesive nature."[2]

Mercury-free materials like composite offer the invaluable benefits of preserving tooth structure and strengthening teeth:

- SCENIHR explains that mercury-free dental fillings "have facilitated a radical change in the concepts of restorative dentistry through the introduction of more minimally invasive techniques and the associated retention of more tooth substance when treating caries."[3]

- The World Health Organization (WHO) states that "Adhesive resin materials [like composite] allow for less tooth destruction and, as a result, a longer survival of the tooth itself. Funding agencies should take the initiative and encourage the replacement of amalgam as the material of choice for posterior teeth with adhesive systems."[4]The WHO adds "It may be more important to examine tooth survival and to preserve tooth structure than filling survival…Preservation of the tooth in a functional state should be taken into consideration rather than retention of the material used for restoration; this is in line with goals for oral health suggested by WHO."[5]

- As explained in the 2012 EC-commissioned BIOIS report, "Outside the fact that they eliminate the need for mercury in dentistry, one main advantage of Hg-free restoration techniques are that they are less invasive and use filling materials which react with the tooth tissue to form new, permanent tissue with a composition close to the original one. Such techniques leave more intact tooth tissue in the treated tooth as compared with dental amalgam restoration. While dental amalgam placement tends to weaken the overall tooth structure (due to the significant amount of healthy tooth tissue that has to be removed), ART [atraumatic restorative treatment, a technique for placing glass ionomer fillings]and other Minimally Invasive Techniques will most likely prolong the life of the tooth before implants (expensive) and/or extraction will be necessary. In a recent WHO report, it was concluded that *'fostering the philosophy of preserving the tooth structure and improving the survival of the tooth is imperative'*."[6]

- Roeters *et. al.* found that "Longevity should not be the only way to look at a restorative material though this has always been the case with dental amalgam. Using dental amalgam the cavity preparation needed to be adjusted to meet the requirements of the material. Instead of this *one should question in what way the tooth can be preserved as long as possible*. Composite resin, glass ionomer cements and compomers do not require the more traditional preparation required for amalgam and adhesive restorative materials and techniques can be adjusted to all kinds of cavity shapes. As a consequence much less sound tooth tissue will be sacrificed. An *in vivo* study showed that when primary caries lesions in the occlusal surfaces of first molars were restored with amalgam the surface occupied by the restoration was five times larger than when a composite resin was used. This means that a composite restoration can be replaced several times before the same amount of tooth material as with amalgam is lost. However, when composite resin restorations fail on the long term, there is no need to replace them completely as they can be repaired."[7]

- The American Academy of Pediatric Dentistry found that "Resin-based composites allow the practitioner to be conservative in tooth preparation. With minimal pit and fissure caries, the carious tooth structure can be removed and restored while avoiding the traditional "extension for prevention" removal of healthy tooth structure."[8]

- Lynch *et. al*. says, "Until recently, practitioners and researchers have judged the suitability of a restorative material according to its mechanical properties and its likely longevity compared with those of another restorative material. Within the past several years, it has become more important to select a restorative material on the basis of the likely life span of the restored tooth, rather than to focus on the potential performance of the restorative material itself. Such an approach is in keeping with a biological, rather than a surgical-mechanical, approach to operative dentistry."[9]The researchers went on to conclude that "In contrast, use of resin-based composite allows practitioners to avoid removing healthy tooth structure to achieve retention and resistance form, enabling the procedure to be minimally invasive."[10]

2. Mercury-free fillings can last as long – or longer – than amalgam

Many studies verify that composite's longevity is comparable – if not superior – to amalgam:

- SCENIHR acknowledges that "the quality and durability of alternative materials have improved.…The SCENIHR concludes that dental restorative treatment can be adequately ensured by amalgam and alternative types of restorative material. The longevity of restorations of alternative materials in posterior teeth has improved with the continuing development of these materials and the practitioner's familiarity with effective placement techniques….some recent studies from the Netherlands, Sweden and Denmark showed very good long-term clinical effectiveness for posterior resin composite restorations with equal and better longevity than for amalgam."[11]

- According to the World Health Organization, "recent data suggest that RBCs [resin-based composites] perform equally well" as amalgam.[12]

- The 2012 EC-commissioned BIOIS report concluded, "Given the results of recent studies comparing the longevity of different materials, in the presentstudy it is considered that the

longevity of Hg-free fillings is no longer a factor with significanteffect on the overall cost difference between dental amalgam and composite or glass ionomerrestorations."[13]

- Opdam *et. al.* (2007) did a study comparing amalgam and composite longevity (published in *Dental Materials*), which concluded "Life tables calculated from the data reveal a survival for composite resin of 91.7% at 5 years and 82.2% at 10 years. For amalgam the survival is 89.6% at 5 years and 79.2% at 10 years. Cox-regression analysis resulted in a significant effect of the amount of restored surfaces on the survival of the restorations. No significant effect of operator, material as well as combination of material and operator was found…In the investigated general practice, two dentists obtained comparable longevity for amalgam and composite resin restorations."[14]

- The latest studies show that composite not only lasts as long as amalgam, but actually has a higher overall survival rate.[15] According to a 2010 study over the course of 12 years, "Large composite restorations showed a higher survival in the combined population and in the low-risk group."[16] Amalgam survived better only in narrow circumstances: for "three-surface restorations in high-risk patients, amalgam showed better survival."[17]

- Composites have progressed so far over the past decade that researchers say older studies on composite are irrelevant. As Lynch *et. al.* explain, "Since then, researchers have made such enormous advances in all aspects of resin-based composite use in the restoration of posterior teeth that reference to the literature of the 1990s increasingly may be viewed as irrelevant for contemporary practice. This is illustrated by the results of practice based studies indicating the increased popularity and effectiveness of posterior resin-based composites. These findings show that the performance of resin-based composite restorations now matches, if not exceeds, that of amalgam restorations."[18]

SCENIHR found that amalgam only lasts longer than composite under narrow clinical situations, not routine dental fillings, finding composites' longevity "in certain clinical situations (e.g. large cavities and high caries rates) still inferior to amalgam."[19] The EU could be easily address this narrow circumstance as Denmark did, with a specific exemption (albeit, even under these circumstances, the advantages of modern mercury-free fillings – including the retention of tooth tissue – would outweigh the possibility that amalgam might last longer.):

Longevity of the restoration is not a relevant concern when it comes to the young children whose developing neurological systems are most susceptible to mercury's neurotoxic effects – their baby teeth will fall out long before the restoration fails:

- As the World Health Organization report *Future Use of Materials for Dental Restoration* explains, "Alternative restorative materials of sufficient quality are available for use in the deciduous [baby] dentition of children."[20]

- The 2012 BIOIS report elaborated that "With regard to young children, longevity of the restoration is not a relevant concern since baby teeth will fall out long before the restoration fails."[21]

Further undermining amalgam's relevance for children is the fact that composite has lower failure rates than amalgam in children's primary teeth:

- Hickel *et. al*. found that amalgam has a mean annual failure rate of 7.6% in children's primary teeth, meaning almost one amalgam filling in 12 fails in young children. This high 7.6% failure rates contrasts with 5.9% for composite and 3.3% for compomer, and with only 4.2% for resin-modified glass ionomer. The study determined that "the failure of amalgam restorations occurs more frequently in primary teeth, especially in small children, due to moisture contamination of the cavities during condensation. The age of the children at the time of placement is therefore a major factor in restoration longevity."[22]

SCENIHR already concludes that "use of amalgam restorations is not indicated in primary teeth" and recommends "that for the first treatment of primary teeth in children and for pregnant patients, alternative materials to amalgam should be the first choice,"[23] In addition to that, the irrelevancy of filling longevity in short-lived primary teeth and amalgam's higher failure rates in primary teeth, clearly leave no justification for amalgam's continued use in children's primary teeth.

3. Mercury-free fillings can be placed as fast as amalgam

It generally does not take dentists any more time to place a composite than it does an amalgam:

- According to a 2012 BIOIS report prepared for the European Commission, "it has been shown that the time needed to carry out a Hg-free [mercury-free] restoration has reduced significantly as dentists have gained more experience in the handling of Hg-free materials, so that there is currently no (or minor) time difference to perform Hg-free restorations compared to amalgam."[24]

- The BIOIS report went on to explain, "The Dental Service Organisation of the county of Orebro has provided an assessment made in 2007, when amalgam was to some extent still an option relevant for comparison. The assessment clearly shows that the time required to make composite fillings is merely a few minutes longer than for similar amalgam fillings, with time difference of less than 10 percent for all three categories of treatments (one surface, several surfaces and crown)...the Swedish Environment Ministry received a signed statement from the Swedish Dental and Pharmaceutical Benefits Agency (TLV) that is responsible for the Swedish subsidy scheme covering dental care. According to the statement, in preparation of the new dental care reform that went into effect 1 July 2008 in Sweden, TLV gathered extensive information (e.g. on time studies) from several Swedish Dental Service Organisations (among them Orebro county). TLV states that the information in time and resources use, in different types of dental treatments, showed great similarities between dental care providers in Sweden, i.e. that there are only minimal differenced in time use assessments on dental treatments reported from various parts of Sweden. This means that the assessment (on time use difference between amalgam and alternative fillings) made by Orebro County that is referred to above can clearly be said to well represent the situation on the national scale in Sweden. Based on the information above, the Swedish Environment Ministry reported that it is confident that dental restorations with Hg-free dental materials, if they are at all taking longer time, only require minimal extra time when performed by dental staff with regular experience in the field."[25]

- Hendriks *et. al.* found that even in the 1980s when dentists not as well trained in composite use, "Results show that the various factors have a significant influence on the total treatment

time. The treatment time for amalgam restorations is equal to the treatment lime of composite restorations."[26]

Glass ionomers can be placed faster than amalgam:

- A study conducted in Ireland found that atraumatic restorative treatment (ART), a technique using glass ionomer fillings, can be completed more quickly than either amalgam or composite: "In order to estimate costs for treating patients with either ART or CT [conventional technique; i.e. amalgam or composite] technique, the procedure for placement of restorations was timed using a stopwatch. The stopwatch was started when the patient had his mouth open and the dentist was about to start the restorative intervention and stopped when the chair was brought back to a neutral position and the patient allowed to rinse their mouth if desired. It could be estimated so, the average time to place an ART or a conventional restoration... The average time of procedures was 13 minutes for ART and 18 for conventional restorations. It was estimated then that 32 restorations could be performed using the ART technique per day and 23 conventional restorations...."[27]

- Atraumatic restorative treatment (ART), a technique using glass ionomer fillings, can be completed more quickly than amalgam restorations according to a 2009 study conducted in South Africa (which also found it takes the same amount of time to do a composite as an amalgam): "Duration of procedure for one amalgam and one composite restoration is estimated as an average of 22 minutes; ART restorations are estimated to take 19.8 minutes."[28]

Three factors can account for any minor difference in the time it takes to place composite and amalgam:

- First, the range of time may vary depending on whether the tooth structure has already been damaged by amalgam. Composite is often used to replace a previous amalgam restoration. As explained in the BIOIS report, "the time required for a composite to replace a previous amalgam restoration is higher than for replacing a composite filling: a cavity originally prepared to receive an amalgam filling is typically larger and distinguished by various angles that would never be prepared for a composite, rendering the placement of a composite more difficult and time-consuming than it would otherwise have been."[29]

- Second, the range of time may vary depending on the training of the dentist. Dentists who have more experience in using composite say that they can place composite just as fast as amalgam. But some dentists have not been trained sufficiently enough in composite use – surveys of dental schools' instruction in posterior resin-based composite placement from the late 1990s "revealed that most graduates had little or no clinical experience in placing posterior resin-based composites."[30] A 2011 study elaborated: "Over the past two decades, studies have been conducted in North and South America, Europe and Asia examining the teaching of resin-based materials for restoring posterior teeth. The findings of each study were similar, and concluded that the emphasis on teaching posterior resin composite placement had increased, but most dental graduates had minimal clinical experience with their placement."[31]

- Third, the range of time may vary depending on the experience of the dentist. Uncomfortable with the composite procedure due to lack of training, some dentists then do not use it as

much in their practice. Hence, they never learn to place composite any faster. As the 2012 BIOIS report noted, "dentists who regularly use composites say they can place a composite as fast as an amalgam."[32]It explained that "In Sweden, where dental amalgam has been banned, it has been shown that the time needed to carry out a Hg-free restoration has reduced significantly as dentists have gained more experience in the handling of Hg-free materials, so that there is currently no (or minor) time difference to perform Hg-free restorations compared to amalgam."[33]

All three of these factors exist only because of the continuing use of amalgam. They will no longer exist after amalgam use is phased out.

4. Mercury-free fillings can help prevent caries, unlike amalgam

Mercury-free fillings have properties that can help prevent caries:

- Glass ionomer releases fluoride over time, which can help prevent dental caries. For example, Mandari *et. al.* found that "Secondary caries was observed for 2% of glass-ionomer and for 10% of amalgam restorations.This difference was statistically significant ($p = 0.001$). The ART approach using glass-ionomer performed equally well as conventional restorative approaches using electrically driven equipment and amalgam for treating dentinal lesions in occlusal surfaces after 6 years."[34]

- Lynch *et. al.* notes that composites placement can also incorporate preventive measures, including sealing of adjacent pits and fissures.[35]

5. Mercury-free fillings can be repaired more easily than amalgam

Not only does composite save tooth structure during the initial placement, but it permits localized repairs instead of total restoration replacement. This saves both tooth structure and costs:

- Roeters *et. al.* found that "when composite resin restorations fail on the long term, there is no need to replace them completely as they can be repaired. By doing this the 'tooth countdown' repeat restorative cycle is halted."[36]

- Lynch *et. al.* concludes that "predictable techniques exist for the refurbishment or repair of resin-based composite restorations that exhibit signs of deterioration, staining or marginal degradation. Such minimally invasive approaches permit localized repair, thereby avoiding the consequences of total restoration replacement, including an inevitable increase in the depth and width of the cavity preparation and an unnecessary challenge to the viability of the pulp-dentin complex. These tooth-friendly features of resin based composites make them *preferable to amalgam*, which has provided an invaluable service but which, we believe, now should be considered *outdated for use in operative dentistry*."[37]

- Opdam *et. al.* found that composite can be repaired more successfully than amalgam, explaining that "The annual failure rate (AFR) after 4 years for repairs of amalgam

restoration was 9.3%, while the AFR of repaired composite restorations was 5.7%. The log-rank test revealed a significant superior performance of repairs of composite restorations (p = 0.001)... The results of the study as shown in Fig. 4 and the log-rank test indicating high significance suggest that a composite restoration can be repaired more successfully than an amalgam restoration." The reason was that "In the present study it was found that repaired restorations in case of tooth fracture, which is a common failure type among large amalgam restorations, have a worse prognosis then repaired restorations due to recurrent caries, which is more common among the composite resin restorations investigated. This is likely to explain as a repaired restoration in case of e.g. a cusp fracture (Fig. 2) will be subjected to the same forces that caused the same cusp fracture, leading to a second fracture soon. On the other hand, a secondary caries lesion in a large composite resin restoration that is repaired with a local box-type restoration (Fig. 3) is likely to survive longer due to the fact that a new secondary caries lesion needs at least three years to develop to a size making a new operative intervention necessary. Moreover, preventive measures taken may cause the demise of caries activity in the patient preventing new secondary caries lesions to develop."[38]

6. Mercury-free fillings are safer than amalgam

Studies show that mercury-based amalgam fillings are not safe for everybody and pose particular risks for children. For example:

- In 2015, SCENIHR concluded that "The use of amalgam restorations is not indicated in primary teeth, in patients with mercury allergies, and persons with chronic kidney diseases with decreased renal clearance....To reduce the use of mercury-added products in line with the intentions of the Minamata Convention (reduction of mercury in the environment) and under the above mentioned precautions, it can be recommended that for the first treatment of primary teeth in children and for pregnant patients, alternative materials to amalgam should be the first choice."[39]

- Woods *et. al.* found that "Mercury (Hg) is neurotoxic, and children may be particularly susceptible to this effect…. the present studies demonstrate significant adverse effects on neurobehavioral functions associated with chronic Hg exposure [from amalgam] and the CPOX4 genetic variant among children, with effects manifested predominantly among boys. These findings are the first to describe a genetic polymorphism that modifies the effects of Hg exposure on neurobehavioral functions in children…" The study concludes that "These findings have important public health implications"...but public health officials at IHS ignore them.[40]

- In the study *Maternal amalgam dental fillings as the source of mercury exposure in developing fetus and newborn*, Palkovicova concluded "Levels of Hg in the cord blood were significantly associated with the number of maternal amalgam fillings (rho=0.46, P<0.001) and with the number of years since the last filling (rho=-0.37, P<0.001); these associations remained significant after adjustment for maternal age and education. Dental amalgam fillings in girls and women of reproductive age should be used with caution, to avoid increased prenatal Hg exposure."[41]

- Da Costa found that "The Pearson correlation coefficient was significant (r = 0.6087, p = 0.0057) between breast-milk Hg and number of amalgam surfaces. In 56.5% of low-fish-

eating mothers, the amount of Hg likely to be ingested by breast-fed infants is above the World Health Organization reference."[42]

While amalgam is a major source of mercury exposure, BPA is not even a direct ingredient in composites.[43] Instead, dental resins are composed primarily of BPA derivatives rather than pure BPA. BPA glycidyl dimethacrylate (bis-GMA) is the derivative used most frequently as the base of the resin.[44] No scientific studies have been identified to date which show that bis-GMA can be converted into BPA.[45] Although there are some suggestions that Bis-DMA can under certain conditions be converted into BPA, it is an uncommon ingredient in composite and in any case the potential is transitory: the BPA level in saliva returns to baseline within several hours or a couple of days.[46] Dental associations, governments, and scientific organizations around the world agree that composite is safe for humans and the environment. Here are a few examples:

- *European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR):* In its 2015 final *Opinion on the Safety of the Use of Bispenol A in Medical Devices*, SCENIHR concludes that "From the available data, concerning exposure via the oral route it can be concluded that the oral long-term exposure via dental material is far below the current oral t-TDI of 4µg/kg b.w./day and poses negligible risk for human health."[47] In fact, it found that BPA could not even be detected in the vast majority of dental composite brands.[48]

- *European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR):* In its 2015 final *Opinion on the Safety of Dental Amalgam and Alternative Restoration Materials for Patients and Users*, SCENIHR concludes "There is no evidence that infants or children are at risk of adverse effects arising from the use of alternatives to dental amalgam."[49]

- *Swedish Chemicals Agency (KEMI):* "Risk assessments of BPA have so far generally concluded that exposure from dental materials does not contribute significantly to total exposure…"[50]

- *World Health Organization & Food and Agriculture Organization of the United Nations Expert Meeting:* "BPA levels in saliva from dental materials were low. The Expert Meeting determined that there was no need to collect additional data on BPA levels from dental materials, as exposure is short term and unlikely to contribute substantially to chronic exposure."[51]

- *BIO Intelligence Service:* As BIOIS explains, "There is currently no scientific evidence to show that the very small concentration of BPA [in dental fillings] has any [direct] adverse health impacts; the quantities released are indeed much lower than in other current application of this widely used compound."[52]

- *British Dental Association (BDA):*The BDA adopted an official position statement on BPA in filling materials: "as the majority of sealants and filling materials only contain Bis-GMA, there will be no resultant oestrogenic effect from using these materials."[53] In 2011, BDA issued a "fact file" reviewing the risks of BPA in filling materials in even greater detail. [54] It concluded: "Current evidence suggests that only a very small and specific group of dental materials is susceptible to the release BPA, and then in only very small amounts. The majority of resin based dental materials appears not to release BPA, which should alleviate

concerns regarding potential health risks…It would appear that BPA is released from only a small number of resin-based dental materials. Thus the contribution of dental materials to the overall body/environmental burden of BPA is very small indeed. Also, where BPA release has been detected, the amounts involved have been very low and well within the TDI of 0.05mg/kg bw/day set by the EFSA... Expert opinion currently suggests that BPA doses from dental materials are low and well within the safe exposure limits."[55] The BDA's fact file concludes with a long list of dental materials that did not release BPA at all when tested, including:

Material	**Manufacturer**
Delton	Dentsply Trubyte
Concise	3M/ESPE
Helioseal	Ivoclar
Prisma Shield	Dentsply Caulk
Seal-Rite I	Pulpdent Corp
Seal-Rite II	Pulpdent Corp
Defender	Henry Schein
Filtek Supreme XT	3M/ESPE
ClearFill Core	Kuraray
Filtek Silorane	3M/ESPE

- *Canadian Dental Association (CDA):* On its website, CDA says "Most sealants and resins contain no (or very little) bisphenol A and it does not release in the application… These materials, including resins and sealants, are all very low risk."[56]In a letter to the media, CDA explained "Learned scientists around the world have carefully examined the BPA content issues related to dental materials and concluded that there is no risk. Health Canada's researchers reached the same conclusions, realizing that there is a world of difference between polycarbonate plastic baby bottles that might be filled with boiling hot water – compared to resin dental fillings that will never be exposed to extreme heat."[57]

- *American Dental Association (ADA):*In 2010, the ADA Council on Scientific Affairs concluded "ADA research, confirmed by direct communications from dental manufacturers, indicates that BPA is rarely used as a formula ingredient in dental products…based on current evidence, the ADA does not believe there is a basis for health concerns relative to BPA exposure from any dental material…Based on current research the Association agrees with the authoritative government agencies that the low-level of BPA exposure that may result from dental sealants and composites poses no known health threat."[58]

- In 2012, a risk assessment comparing amalgam and the alternatives was released by the Health Care Research Collaborative of the University of Illinois at Chicago School of Public Health, the Healthier Hospitals Initiative, and Health Care Without Harm. These researchers conclude, "there is no current evidence of significant personal or environmental toxicity" from the non-mercury alternatives.[59]

7. Mercury-free fillings are safer for the environment

A report by UNEP shows that, per capita, the European Union largest user of dental mercury in the world – consuming at least 90 tons in 2010.[60] While this is due in part to more universal dental care than is available in other regions, the stark reality is the E.U. is the #1 dental mercury polluter; as this AMAP/UNP report shows, all other regions consume significantly less dental mercury[61]:

AMAP/UNEP Technical Report (2013)

Table A3.1. Mercury consumption in products by world region and application, 2010. Source: Maxson (2012, pers. comm.).

	Batteries	Measuring devices	Lamps	Electrical devices	Other use[a]	Dental applications[b]	Total
Average, t							
East and Southeast Asia	191	98	42	50	56	67	504
South Asia	26	27	13	18	21	24	129
European Union (27 countries)	23	15	18	2	105	90	253
CIS and other European countries	7	17	7	10	12	10	63
Middle Eastern States	5	13	6	7	6	16	53
North Africa	2	5	2	4	2	5	20
Sub-Saharan Africa	4	9	4	6	5	6	34
North America	11	34	15	43	76	34	213
Central America and the Caribbean	4	10	4	5	7	17	47
South America	16	18	10	10	13	33	100
Australia New Zealand and Oceania	2	4	2	3	2	4	17
Total	291	250	123	158	305	306	1433

Much of this dental mercury ends up in the environment:

- According the Concorde East/West report Mercury in *Dental Use: Environmental Implications for the EU*, "The remaining approximately 77 tonnes likely ends up in various environmental media, chiefly the soil (30 tonnes) and atmosphere (23 tonnes). In addition, important amounts are released to surface waters (14 tonnes) and groundwater (10 tonnes)."[62]

- BIOIS's Study on the Potential for Reducing Mercury Pollution from Dental Amalgam and Batteries has a table comparing dental mercury releases and overall mercury releases in the EU[63]:

Table 17: Comparison between dental Hg release estimates and overall Hg releases in the EU

Environmental media	Hg releases from dental amalgam use (t/year) (1)	Available data on overall anthropogenic Hg releases in the EU (t/year) (low-end estimates)	Dental amalgam use contribution to EU releases (high-end estimates)
Air	16 - 23	EU report under UNECE Convention on LRTAP (2): 73 t in 2009 E-PRTR (3): 31.3 t in 2009 (only industrial facilities). The main contribution is from coal combustion plants (16.1 t, i.e. 51%) Sunseth et al.(4): 105 t in 2005	Based on LRTAP data: 21 - 32% (5)
Surface water	2 - 4	E-PRTR (6): 6.33 t in 2009 from industrial facilities (including urban WWTPs contributing 2.52 t, i.e. 40%) Sunseth et al. (4): 27 t in 2005 (urban WWTPs estimated to contribute 6 t, i.e. 22%)	Based on Sunseth et al. data: 9 - 13% (7)
Soil and groundwater	16 - 24	E-PRTR (8): 0.26 t in 2009 from industrial facilities (including urban WWTPs contributing 0.213 t, i.e. 82%), however this value only covers a very small proportion of overall Hg releases to soil	Not quantifiable

Once in the environment, SCHER has confirmed that dental amalgam in the environment can methylate (forming the most toxic form of mercury, methylmercury), that as a result "the acceptable level in fish is exceeded" under some circumstances, and thus there is "a risk for secondary poisoning due to methylation."[64]

Meanwhile, mercury-free composites and glass ionomers are safe for the environment:

- *European Commission Scientific Committee on Health and Environmental Risks (SCHER):* "Due to the low mammalian toxicity of these compounds, indirect risks to human health from release of the alternatives [to amalgam] without mercury are estimated as low."[65]

- According to a 2012 study by the Health Care Research Collaborative of the University of Illinois at Chicago School of Public Health, the Healthier Hospitals Initiative, and Health Care Without Harm, "there is no current evidence of significant personal or environmental toxicity" from the non-mercury alternatives.[66]

[1] European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), *Final opinion on the safety of dental amalgam and alternative dental restoration materials for patients and users* (29 April 2015), http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_046.pdf, p.42

[2] Christopher D. Lynch, Kevin B. Frazier, Robert J. McConnell, Igor R. Blum and Nairn H.F. Wilson, *Minimally invasive management of dental caries: Contemporary teaching of posterior resin-based composite placement in U.S. and Canadian dental schools*, J Am Denta Assoc 2011; 142; 612-620, http://jada.ada.org/content/142/6/612.abstract

[3] European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), *Final opinion on the safety of dental amalgam and alternative dental restoration materials for patients and users* (29 April 2015), http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_046.pdf, p.69

[4] World Health Organization, *Future Use of Materials for Dental Restoration* (2011), p.16.

[5] World Health Organization, FUTURE USE OF MATERIALS FOR DENTAL RESTORATION (2011),http://www.who.int/oral_health/publications/dental_material_2011.pdf, p.27, 29
[6] BIO Intelligence Service (2012), *Study on the potential for reducing mercury pollution from dental amalgam and batteries*, Final report prepared for the European Commission-DG ENV, http://ec.europa.eu/environment/chemicals/mercury/pdf/Final_report_11.07.12.pdf, p.77
[7] JJM Roeters, ACC Shortall, and NJM Opdam, *Can a single composite resin serve all purposes?*, *BRITISH DENTAL JOURNAL* **199**, 73 - 79 (2005), http://www.nature.com/bdj/journal/v199/n2/full/4812520a.html (emphasis added)
[8] American Academy of Pediatric Dentistry, *Guideline on Pediatric Restorative Dentistry* (revised 2008), http://www.aapd.org/media/Policies_Guidelines/G_Restorative.pdf
[9] Christopher D. Lynch, Kevin B. Frazier, Robert J. McConnell, Igor R. Blum and Nairn H.F. Wilson, *Minimally invasive management of dental caries: Contemporary teaching of posterior resin-based composite placement in U.S. and Canadian dental schools*, J AM DENTA ASSOC 2011; 142; 612-620, http://jada.ada.org/content/142/6/612.abstract
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