Tooth filling materials

Dental amalgams & alternative materials

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Summary & Details:
GreenFacts

Level 2 - Details on Tooth filling materials

The answers to these questions are a faithful summary of two opinions produced in 2008 by scientific committees of the European Commission: "The safety of dental amalgam and alternative dental restoration materials for patients and users" by SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks) and "The environmental risks and indirect health effects of mercury in dental amalgam" by SCHER (Scientific Committee on Health and Environmental Risks).

The full publication is available at: https://copublications.greenfacts.org/en/dental-amalgam/
and at: http://ec.europa.eu/health/opinions/en/dental-amalgam/

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1. Introduction


Amalgam fillings

Dental amalgam is a combination of one part liquid mercury with one part of a metallic alloy which mainly contains silver and tin. It has been used for over 150 years to restore decayed teeth, and its use has stirred controversy from the earliest days. To make the amalgam, mercury is mixed with the other metals to form a paste that can be fitted to the tooth cavity. The mixture sets relatively fast to form a hard alloy.

At the time of the introduction of amalgam into dentistry, gold could be used in some types of dental restorations, but its cost prohibited widespread use. In the 19th Century, there were no other synthetic materials that had both the required mechanical properties and the ease of placement. As a metallic alloy, amalgam did not look particularly good, but the increasing prevalence of dental caries at the time meant that this was a minor consideration. The even more profound increase in caries throughout the twentieth century, through the widespread use of refined sugars in foodstuffs, resulted in the increased use of dental amalgam fillings.

Although dental amalgam is extremely strong and durable and may still be considered a material of choice for some fillings in the back teeth, it has some drawbacks:

- It is not tooth-coloured so it is very visible, even more so in front teeth.
- It does not adhere to the surface of the tooth cavity, so dentists have to drill out relatively large holes in the teeth to securely fasten the filling.
- It contains mercury that is toxic in some forms. There is concern that mercury could be released during placement, normal corrosion and wear, and removal of a filling, and that it could lead not only to local effects in the mouth but also to effects in the body as a whole, for instance on the nervous system.

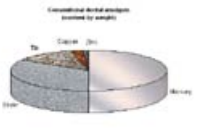
In recent years, alternative tooth-coloured materials have been developed for dental restorations and are increasingly used across the EU. These include composite materials, glass ionomer cements and a variety of hybrid structures.

This report considers whether mercury and the other components of amalgams and alternative restorative materials are safe for dental patients and workers. These alternatives include any chemicals used for the adhesion of the filling materials to the tooth and any light sources used to harden the material. The whole life-cycle of the restoration is taken into account: from manufacture, through placement, to degradation or wear in use and removal.

The report also assesses the exposure of the general population to mercury from dental amalgams released into the environment for instance through wastewater from dental offices (when fillings are placed or removed), and emissions into air from crematoria. Similar considerations on effects on the environment and indirect effects on humans are made for alternative materials although there is much less information available on these.

The toxicity of mercury has been extensively researched and there is a wide variety of scientifically-based sources of information on its health effects. However, some of the alternative materials are relatively new and little is known about their safety.

2. How are dental amalgams made?



Conventional Dental Amalgam
[see Annex 1, p. 15]

Mercury is a metal that can exist as the pure element or combined with other elements to form inorganic and organic compounds. The pure, 'un-combined' form, elemental mercury, is liquid at room temperature and slowly forms a vapour in the air. Chemical reactions and biological processes can transform mercury from one form to another. In general, organic compounds are the most toxic form of mercury, followed by elemental mercury and by inorganic compounds.

Dental amalgam is a mixture of 50% elemental mercury with a metallic alloy which mainly contains silver and tin. The liquid mercury is mixed with the alloy powder in a 1 to 1 weight ratio.

Most dental alloys contain a mixture of silver and tin in a 3 to 1 weight ratio, as well as a lesser portion of copper and zinc. A conventional dental amalgam alloy will contain between 67% and 74% silver, with 25-28% tin, and up to 6% copper, 2% zinc and 3% mercury. Other types of alloys exist, such as the so-called dispersion type amalgam alloys which have around 70% silver, 16% tin and 13% copper. A further, quite different, group of amalgam alloys may contain up to 30% copper, and are known as high-copper content amalgam alloys.

In the past, dentists mixed amalgam by hand which could expose them to mercury vapours. Today, manufacturers usually supply the materials to make the amalgam in a sealed capsule with two compartments. One side contains liquid mercury and the other side holds a mixture of alloy as a powder or tablet. The capsule can be placed in a machine that breaks the membrane between the two compartments and mixes the contents. The dentist collects the mixed amalgam, which at this stage has the consistency of a thick paste, and presses it firmly into the prepared tooth cavity. During this process, some mercury rises to the surface and to make the restoration strong the dentist needs to remove as much of this excess mercury as possible. The amalgam begins to harden almost immediately but there is some retained mercury that continues to react very slowly within the filling.

The mercury contained in dental amalgam once it is placed is in a very different form to that in the liquid mercury. The release of mercury vapour from a set amalgam is much lower than that from the liquid metal.

3. How can dental patients and workers be exposed to mercury from amalgams?

Patients are mainly exposed when fillings are placed or removed © Therese Chase

Patients are mainly exposed when fillings are placed or removed © Therese Chase

Mercury occurs in the environment mainly naturally, but also as a result of human activities. Mercury is present in different forms: either as a pure metal, in various minerals, or in organic compounds, such as methylmercury, which can bioaccumulate in living organisms and reach high levels in fish and marine mammals.

It can be released into the atmosphere by volcanic eruptions, natural weathering of rocks, and through human activities such as the burning of fossil fuels.

The general population can be exposed to mercury through food, water and air as well as through the use of cosmetics, medicinal products and medical devices that contain mercury, including dental amalgams.

The exposure of individuals to mercury varies widely depending on their lifestyle and on the levels of mercury in the local environment. An important source of mercury for the general population is the diet. In particular, eating large amounts of some fish and seafood products can result in exposure to organic mercury above tolerable levels.

Those who work in mercury-related industries and practices may be particularly exposed.

Patients are also exposed to mercury from their **dental restorations**, particularly through the release of mercury vapour from amalgams, which can be breathed in directly. The level of exposure is highest during placement and removal. Exposure to mercury from fillings that are in place depends on the number of fillings, the filling size, composition, surface, age and placement, the chewing habits, food texture, grinding and brushing teeth and many other physiological factors.

In general, once they are in place, exposure to mercury from amalgam fillings is well below recognised tolerable limits, even for individuals with a large number of restorations. Since the main exposure happens when placing or removing amalgam fillings, it is better to leave them in place unless there is a medical reason to remove them.

Although **dental workers** do not touch amalgam and usually wear gloves and face masks, they breathe in mercury vapours, particularly during placement and removal of fillings. As a result, and despite improvements in technique and in mercury hygiene measures, exposure to mercury is normally higher for dental workers than for the general population.

During pregnancy and early life, children can be exposed from a variety of sources to organic and inorganic mercury– through their mothers in the womb and during breast-feeding. However, exposure levels are extremely low and no adverse effects have been reported during pregnancy and early life. The concentration of total mercury in human breast milk is considered to be too low to pose any risk to infants.

Once it is taken in, mercury spreads throughout the whole body. Depending on the form of mercury, different samples are most telling about exposure, blood and urine giving the best information. Measurements of total mercury in the urine tend to reflect inorganic mercury exposure and total mercury levels in whole blood are more indicative of methylmercury exposure.

4. What health effects could be linked to the form of mercury contained in dental amalgams?

4.1 How toxic are mercury and other metals used in amalgams?

The way mercury affects the body is highly dependant on how it enters the body and on its chemical form. People can be exposed to mercury released from amalgams by breathing in mercury vapour or by swallowing either elemental mercury leaching from the fillings or small pieces of amalgam that detach from the filling and that can go on to release mercury inside the gut.

Dental workers are more exposed than the general population
© Marcelo Terraza

Very little of the elemental mercury that comes into contact with the skin or that is swallowed is absorbed into the blood stream. However, a large part of mercury breathed in as vapours is absorbed in the lungs and distributed to the entire body, reaching all organs. The elemental mercury reacts and attaches itself to proteins within the body and is gradually eliminated, mainly through the urine and faeces, reducing its concentration in the body by half every three months in the absence of any additional exposure. The highest concentration of mercury following exposure is usually found in the kidney.

The exposure to mercury vapours from amalgam fillings is fairly low, 5 to 30 times lower than the limits set for workplace exposure, and many orders of magnitude lower than those that can cause long term health effects. In cases of long-term and regular exposure to mercury vapours, for instance in certain work environments considered poor by present standards, the central nervous system is particularly affected. The neurological symptoms can include increased excitability and tremors in fingers, eyelids and lips, which may progress to long term shaking of hands and feet. In addition it can affect the kidneys and cause inflammation of the gums and production of excessive amounts of saliva with a strong metallic taste. Exposure to extremely high doses of mercury – as experienced by some individuals working under poor conditions – may also produce bronchitis and pneumonia.

Dental amalgam can contain silver, zinc, copper, and tin and exposure to excessive doses of these metals can be harmful. The health effects depend on the metal involved and include skin irritation, nausea, vomiting and diarrhoea. More specifically:

- **Silver** is widely used in industry and for medicinal purposes, and it is present in our food. At very high concentrations it can cause local irritations and a deposition of silver in tissues, but no other harmful effects are known.
- **Copper** is an essential micronutrient. Copper deficiencies can for instance cause anaemia but exposure to excessive levels can also lead to anaemia and damage the liver, kidney and the immune system.
- **Tin** dust and fumes can cause lung problems, and if ingested, inorganic tin can cause nausea, vomiting and diarrhoea. Excessive doses of tin can affect the way the body process other metals like copper, zinc and iron.
- **Zinc** is also an essential micronutrient, and zinc deficiency can lead to a series of health problems. Ingesting large doses of zinc can lead to digestive problems, and can lead to copper and iron deficiencies.

However, there is no evidence of any adverse health effects caused by the presence of these metals in amalgam fillings, apart from some people having allergic reactions to the individual elements.

4.2 What are the possible negative effects on health of dental amalgams?

The main exposure of patients to mercury from amalgam restorations occurs during placement or removal of the fillings. Therefore, it is more harmful to remove amalgam fillings than to leave them in place, unless the filling is damaged or defective, or the individual has an allergic reaction to one of the components of the amalgam.

Metals in close contact with skin and mucous membranes are well-known causes of allergic skin inflammation and mercury is no exception. Among allergic individuals, reactions to mercury or any of the metals in dental amalgam can result in inflammation of the gums, and in red and painful sores and ulcers in the mouth. The inflammation is not always limited to the mouth and can be observed as rashes in the face or other parts of the body. However, these reactions are rare and removing the filling usually resolves the problem.

There have been claims that amalgams might be involved in many diseases and in some neurological and psychological disorders such as Parkinson’s or Alzheimer’s diseases,

depression and anxiety. However, for many of the claims, scientific investigations have generally provided either refutation or found no link. No link has been found between dental amalgams and chronic fatigue syndrome, kidney diseases, autism, fertility, birth defects or coronary heart disease. There is no indication that amalgam affects the human immune system, and there is no evidence of a link between mercury and human mental health problems or psychological conditions.

Among dental workers, there does not seem to be a link between exposure to mercury and health. Although the level of mercury in the blood is higher in dentists than in the rest of the population, the general health of dentists is good and their lifespan is greater than that for control groups. However, because of possible effects on reproductive health it is important to monitor the levels of mercury in dental clinics to ensure these are not above permitted levels. As the number of amalgam restorations being placed and removed is decreasing, the need for such measures will decrease over time.

The current use of dental amalgam does not harm human health, other than causing occasional local effects, such as allergic reactions, in some dental patients.

Whatever the material chosen, direct restorations may fail, primarily through new caries between the tooth and the filling (secondary caries), fracture of the restoration or tooth, marginal deficiencies or wear. The rates at which these failures occur are difficult to compare since they will vary with clinical technique and from patient to patient. Also, the materials used are not comparable to each other since there have been changes in characteristics and improvements in quality over time.

Dental amalgam remains an effective, strong, durable and relatively cheap tooth filling material particularly resistant to secondary caries, possibly through anti-bacterial activity. It will outlast alternative materials under many circumstances.

5. What are the possible health effects of alternative tooth filling materials?

5.1 How toxic are the different components of alternative materials ?

Tooth fillings are increasingly done using alternative materials such as composites, glass ionomer cements, compomers, giomers and sealants. Some of these alternative materials are chemically very complex and not necessarily free from concerns about health effects.


Composites are typically hardened using light

Composites contain many different components, including a resin base and ceramic filler. The product is supplied as a paste that is filled into the tooth cavity. The resin is then typically hardened using visible blue light.

Used since the 1970s, **glass ionomer cements** are formed when glass powder and a type of polymer react with each other. The reaction hardens the material and attaches it firmly to the tooth.

Other materials, such as compomers have been introduced since the 1990s to combine specific advantages of composites and cements.

Sealants are pastes or liquids that are used to seal small surface defects such as pits and fissures in permanent teeth to prevent caries.

Clearly these alternative restorative materials are complex chemically, with different components, properties, and setting reaction mechanisms. They can thus interact with the patient's tissues in many different ways**.**

Substances of particular concern are:

- ions leaching from different types of glass used as filling material ;
- acids used to etch teeth and set the fillings; and
- the small organic molecules (monomers) that react to form polymers, the basis of many alternative materials. Some of the monomers may not have reacted during placement and therefore low levels may remain in the set filling.

Although there is very limited data available, some monomers are known to be toxic to cells and others cause allergic reactions. Some of these substances are irritants when used by themselves. The effects they cause vary depending on the substance and on the type of body tissue with which they come into contact. In addition, many alternative materials release ions. In vitro studies have shown that some of these releases (such as fluorides) are beneficial or too low to be harmful, while others (such as copper, aluminium and iron) may reach concentrations capable of harming cells.

As restorations degrade or erode over time, they release substances that can be absorbed through the skin, the gut, and through the lungs. It is very difficult to determine exposure to the different substances because there are no obvious indicators that could be measured and because the volumes of the materials used are very small and these materials set quickly. In addition, the starting materials change chemically when they set and it is likely that their toxicity also changes.

Although laboratory studies show that some of these leached substances are harmful to cells, the concentrations emitted by restorations during placement and thereafter are usually too small to be considered a significant health problem.

When some alternative materials set, they shrink and leave a gap between the tooth and the restoration. Improvements in techniques and products have led to smaller gaps but some microorganisms can fit underneath restorations and cause harmful effects to the dental pulp.

Dental workers are exposed to some of the components of alternative materials when they prepare and place fillings. There is very limited information on the level of exposure to components of alternative materials present in the air.

5.2 What are the possible negative effects on health associated with alternative materials ?

Alternative tooth-coloured materials contain a complex mixture of chemicals that react with each other inside the tooth cavity and also interact with the surrounding tissues. Some of the components of these materials are highly toxic to gum and pulp cells grown in the laboratory and others can cause mutations. However, these properties may not necessarily lead to negative health effects in dental patients.

Many of the components of alternative materials and their degradation products can cause local allergic reactions in dental patients (mouth) and workers (hands). Such allergic reactions can also affect other parts of the body such as the face, arms or legs. Allergic reactions are more common in dental workers than in patients, probably because the exposure is highest when handling resin-based restorative materials.

Wearing gloves when handling these materials does not prevent very small molecules released from alternative materials to reach the skin, and these molecules may induce reactions in persons sensitive to them. Such reactions can be avoided by not touching these substances even when wearing gloves.

Many alternative materials are hardened by shining visible blue light onto them. The powerful light sources now used for this purpose may constitute an additional risk for adverse effects, both to patients and dental personnel. Eye protection is extremely important. Though these dental curing units are generally considered safe certain people should avoid their use, for instance individuals with certain cataract and other eyesight problems, patients sensitive to light or those on photosensitising medication. Certain electrical equipment used for dental curing may pose a risk to people with electrical implants such as pacemakers.

The full chemical specification of alternative restorative materials is not always divulged and it may be difficult to ascertain exactly what they contain. In the absence of data, it may not be possible to provide a scientifically sound statement on the safety of individual products. There are very limited scientific data available concerning exposure of patients and dental personnel to these substances.

Nevertheless, these alternative materials have now been in clinical use for well over thirty years, and this use has revealed little evidence of clinically significant adverse events. The commercially available materials have either changed substantially or been improved considerably during this time, with reduced exposure to harmful components through improved hardening processes.

6. Conclusion on health effects of dental amalgams and their alternatives on users

6.1 What is the scientific evidence linking dental amalgams to health problems?

For many decades there has been a debate about the possibility that mercury-containing amalgam can cause diseases. In spite of many studies and investigations into this claim, there is no scientific evidence that the current use of dental amalgam poses a risk of disease including kidney disease or neurological and psychological effects such as Alzheimer’s, Parkinson Disease or Multiple Sclerosis. No link has been found between the use of amalgam and the development of brain function in children.

Some local adverse effects are occasionally seen with dental amalgam fillings, including allergic reactions. However, these are rare and normally readily managed.

Because of the way alternative materials are regulated in the EU, when regulatory approval is sought for a specific material it is not necessary to provide a design dossier including a risk analysis and therefore the chemical specification does not have to be revealed. As a result, there is limited toxicological data publicly available for these materials.

The relative risks and benefits of using different tooth filling materials should be explained to patients and the public at large.

6.2 How safe are dental amalgams containing mercury?

People with amalgam restorations are likely to have higher levels of mercury in their blood and urine than those without. However, these levels are lower than those that cause adverse health effects. Results from epidemiological studies do not support any links between mercury and any of the diseases that have been suggested as being associated with dental amalgam.

Allergic reactions and other local effects are occasionally seen in individuals with amalgam fillings. However, such effects are rare and removing the restoration usually alleviates the symptoms.

The removal of amalgam restorations will expose the patient to relatively high levels of mercury. Therefore it is safer to leave the filling in place unless the patient has an allergic reaction to dental amalgam.

There is no evidence to suggest that pre-existing amalgam restorations pose any risk to the health of pregnant women and children both before and after birth. Nevertheless, as with any other medical intervention, dentists should be cautious when considering the placement or removal of fillings in pregnant women.

The current use of dental amalgam is safe for patients. Dental health is an extremely important component of general health care and the benefits of amalgam to individuals with decayed teeth far outweigh the very low level of risk associated with allergies.

Dental workers may be more exposed to mercury than the general population. However, very few adverse effects are reported and the risk to dental workers has decreased substantially with improvements in the systems used to mix amalgam and in amalgam hygiene practices in general.

6.3 How safe are alternative tooth filling materials?

Alternative tooth filling materials are made of a complex mixture of chemicals and there is little information on the toxicity and health effects of these.

Although some components of alternative materials have been shown to cause mutations or be harmful to cells, there is no evidence of any adverse health effects associated with such substances, apart from a very few cases of allergies.

There is thus no evidence that tooth fillings containing these materials cause any neurological disorders or any other diseases. As with any other medical intervention or product, dentists should be cautious when placing restorations in pregnant patients.

Alternative tooth filling materials can cause allergic reactions in dental workers, mainly when they handle some of the resins which form the basis of many products. These contain very small molecules that can pass through gloves and can lead to local skin reactions in some individuals, particularly if they have cuts, abrasions or certain skin conditions.

Alternative tooth filling materials are continually being developed. Information on their composition and potential toxicity is sparse, so caution should be exercised before new variations are introduced into the market.

It is difficult to make direct comparisons between dental amalgam and the alternative materials since they are not used in the same way. Amalgams are very strong, cheap and durable and may remain the material of choice for large restorations in back teeth. Alternative materials look better than amalgams, stick to the surrounding tooth and require the removal of less tooth material. However, teeth restored with alternative materials may be more likely to be affected by new caries between the tooth and the filling and, in some situations, alternative materials may be less durable than amalgams.

Dental health can be ensured by both types of material. All the materials are safe as used and associated with very low rates of local adverse effects with no evidence of general principle, the relative risks and benefits of using dental amalgam or the various alternatives should be explained to patients to help them make informed decisions. It would also be beneficial for the community in general to be better informed of the recognized benefits and risks.

In any case, more experimental, clinical and epidemiological research on alternative materials is required to guarantee patient safety in the future since it is expected that the use of dental amalgam will decrease across the European Union in favour of alternative materials and since data on the toxicity, exposure, and health effects of these alternative materials is lacking.

7. What is the environmental risk of the use of dental amalgams and alternative materials?

7.1 Does mercury released by the use of amalgams pose a risk to the environment ?


Methylmercury can accumulate along the food chain © Aurileide Alves

Mercury occurs naturally in the environment in different chemical forms. Elemental mercury is the form used in dental amalgams. Forms more commonly found in nature are inorganic mercury and organic mercury.

Most of the mercury in the environment comes from natural sources such as emissions from volcanoes and soil erosion. However, over the last several centuries the levels of mercury in the environment have increased because of human activity. The widespread use of mercury and its compounds in a number of industries has resulted in larger releases of mercury into the atmosphere. Mercury is present in many cosmetics, medicinal products and medical devices including dental amalgam. Moreover, some mercury compounds – especially the organic form methylmercury – have accumulated in the aquatic food chain.

Mercury from dental amalgam can end up in the soil, atmosphere, surface water and ground water through several routes, including wastewater discharges from dental practices, and emissions to air and soil resulting from the cremation or burial of individuals with dental amalgam fillings.

The amount and the type of mercury released from dental clinics vary widely across the EU depending on levels of usage of dental amalgam and on how the wastewater is treated before it is discharged.

Wastewater released by dental clinics could increase the concentration of **inorganic mercury** in water bodies. The added risk for aquatic organisms is considered low.

Sludge from plants that treat such wastewater present a low risk for soil-dwelling organisms.

The main concern with emissions to water is related to the well-known potential of **methylmercury** – an organic form of mercury – to bioaccumulate (build up inside an organism) and biomagnify (build up along the food chain). All forms of mercury can accumulate in organisms, but methylmercury is taken up at a faster rate than other forms and bioaccumulates to a greater extent. As a result, methylmercury can become increasingly concentrated in aquatic organisms and result in high levels of exposure for fish-eating animals and for humans. Some of the inorganic mercury present in wastewater from dental clinics, for instance, will be converted into methylmercury before its release (up to 0.2% of the total mercury) but also once it reaches the environment. How quickly this conversion takes place depends on the characteristics of the ecosystem and is highly variable. Though estimates are available of the amounts of mercury released by the use and disposal of dental amalgams in the European Union, it is not possible to say what proportion of the risk associated with organic mercury present in the environment is due to releases from amalgams.

At present it is not possible to do a complete risk assessment to human health and the environment of the use of mercury in dental amalgam. In general, the added risk to aquatic and soil organisms from the contributions of dental mercury to the total mercury is considered to be low. Improvements in the treatment of waste water from dental clinics and amalgam waste has generally reduced this environmental exposure. Further studies are needed to assess the environmental effects of burial and cremation of bodies containing amalgam on soils.

7.2 What is the environmental impact of alternative tooth filling materials?

Some of the small organic molecules (monomers) that are used to make the resin base for alternative tooth filling materials are derived from well known chemicals – notably methacrylic acids and glycidyl ethers. Therefore, although data on the toxic effects of these new materials on animals and on the environment are not available, major effects can be extrapolated. For instance, exposures to high levels of a particular type of resin base are expected to cause skin irritation and, if inhaled, are likely to harm the liver and the nervous system.

The available information is too limited to assess the relative effects of dental amalgams and their alternatives on the environment. To assess the full environmental impact it would be necessary not only to determine the risk of environmental contamination and its harmful effects on environmental organisms, but also other environmental effects.

8. How serious are the risks of indirect exposure to mercury from disposal dental amalgams?

Mercury is present throughout the environment and is released by a variety of sources, one of which is the use and disposal of dental amalgams. The general population can for instance be exposed to mercury present in the environment by breathing in elemental mercury vapours in ambient air and by ingesting water and food contaminated with organic mercury.

Daily intake and retention of mercury in the general population [see Annex 2, p. 15]

Table 1: Estimated average daily intake and retention of total mercury and mercury compounds in the general population.

Sources of exposure	Elemental mercury vapour	Inorganic mercury compounds	Methylmercury
Air	0.030 (0.024)	0.002 (0.001)	0.008 (0.0064)
Food			
- Fish	0	0.600 (0.042)	2.4 (2.3)
- Non-fish	0	3.6 (0.25)	0
Drinking water	0	0.050 (0.0035)	0
Dental amalgams	3.8 – 21 (3 – 17)	0	0
Total	3.9 – 21 (3 – 17)	4.3 (0.3)	2.41 (2.31)

The most important source of mercury for people who do not work in mercury-related industries is the diet, particularly fish and other seafood products contaminated with methylmercury. The main sources of exposure to elemental mercury vapours are certain workplaces and the placement of dental amalgams. In general, the toxic effects of mercury depend on the way it reaches the body and on the form of mercury (elemental, inorganic or organic).

The highest risks to human health from mercury in the environment come from methylmercury, an organic form of mercury. It is highly toxic and, in contrast to elemental and inorganic mercury, most of the methylmercury swallowed is absorbed by the gut and distributed rapidly and evenly throughout the body. Human exposures following high dose poisonings can result in mental retardation and impaired senses and movement. Similar effects have also been noted in animals. Long term, low dose exposures in the womb due to consumption of contaminated fish by the mother, have been associated with milder harmful effects on the nervous system.

Limit values have been set for the concentration of methylmercury in fish and for the total daily intake of methylmercury by humans.

Table 2. Limit for mercury intake [see Annex 3, p. 16]

Limit for mercury intake

Dental amalgams are not a major source of methylmercury. The releases to the environment resulting from the use and disposal of dental amalgam are mainly in the form of elemental and inorganic mercury. Only a small fraction of this will be converted into methylmercury. Therefore, the predicted indirect exposures of humans to methylmercury resulting from emissions due to the use of dental amalgams are low. These exposures are much lower than tolerable limits and thus constitute a low risk of serious health effects.

9. What further information is needed on environmental risks of dental amalgams?

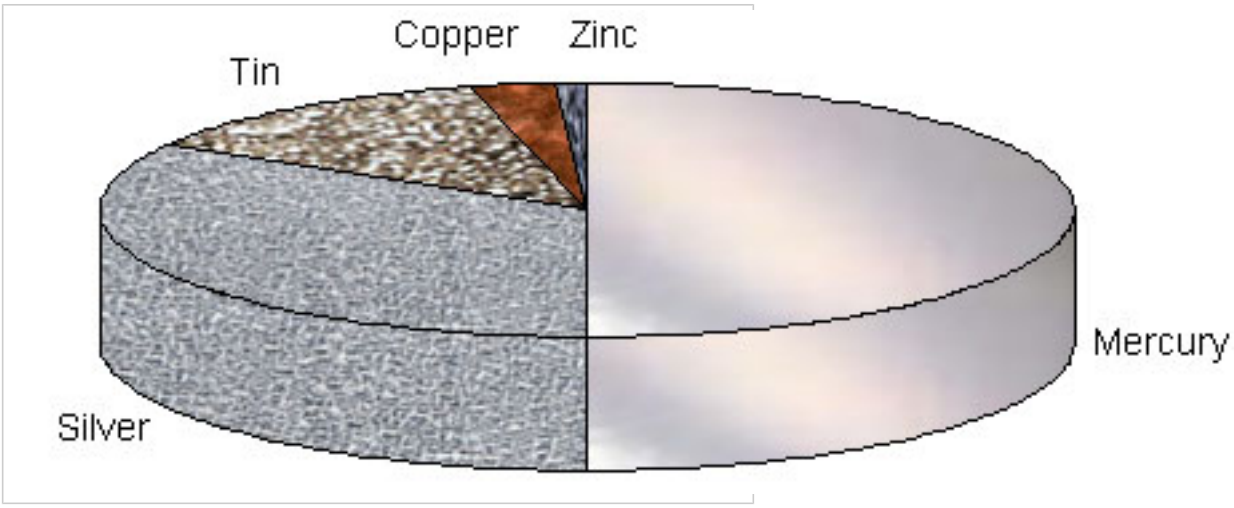
The information currently available is not sufficient to fully assess the environmental risks and indirect health effects from the use of dental amalgam in the EU. To allow this type of assessment, the following information is required:

- More information on how mercury is used and released in all EU countries, particularly on differences in wastewater treatment or on measures taken to prevent emissions or to remove mercury from the environment.

- An updated compilation of all the available data on the effects of mercury and methylmercury on humans and other species in the environment.
- An assessment of the amount of mercury released from crematoria across different parts of the EU and how much of this mercury settles on the soil.
- A review of the available information on how methylmercury accumulates in living organisms under the different conditions found across the EU.
- A detailed calculation of the proportion of the total mercury in the environment that originates from dental amalgam.

Annex

Annex 1:
Conventional Dental Amalgam (content by weight)



Source: GreenFacts

Annex 2:
Table 1. Estimated average daily intake and retention of total mercury and mercury compounds in the general population.

Values given are the estimated average daily intake (µg/day) for adults.
The figures in parentheses represent the estimated amount retained in the body of an adult.

Sources of exposure	Elemental mercury vapour	Inorganic mercury compounds	Methylmercury
Air	0.030 (0.024)	0.002 (0.001)	0.008 (0.0064)
Food			
- Fish	0	0.600 (0.042)	2.4 (2.3)
- Non-fish	0	3.6 (0.25)	0
Drinking water	0	0.050 (0.0035)	0
Dental amalgams	3.8 – 21 (3 – 17)	0	0
Total	**3.9 – 21 (3 – 17)**	**4.3 (0.3)**	**2.41 (2.31)**

Source: SCHER, Preliminary report on the environmental risks and indirect health effects of mercury in dental amalgam (2008) [see http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_089.pdf], 3. Opinion, p.12

Annex 3:

Table 2. Limits for the intake of $Hg2^{+}$ and methylmercury.

Limit value	Refers to	Organisation
0.1 µg/kg/day (methyl-mercury)	„reference dose"	US EPA, 2001
0.3 µg/kg/day ($Hg2^{+}$)	„reference dose"	US EPA, 1987
5 µg/kg/day total mercury, maximum of 1.6 µg/kg/day as methylmercury	Provisional weekly intake	JECFA, 2003

Source: SCHER, Preliminary report on the environmental risks and indirect health effects of mercury in dental amalgam (2008) [see http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_089.pdf], 3. Opinion, p.13