2. Mercury pollution – where does it come from?

The largest source of emissions to the atmosphere is currently coal fired power stations, however, the widespread use of mercury in dental amalgam means that in the future, crematoria could become the most significant source. Hospitals with medical waste incinerators are also a major contributor to the mercury problem, and although emissions are decreasing as the number of medical waste incinerators is reduced, there is concern within the health community that the use of mercury in healthcare products is exposing patients and other vulnerable groups. The chlor-alkali industry, the biggest single user of mercury in Europe, has released many tonnes of mercury to the aquatic environment over the years, and contributed to fish contamination[52].

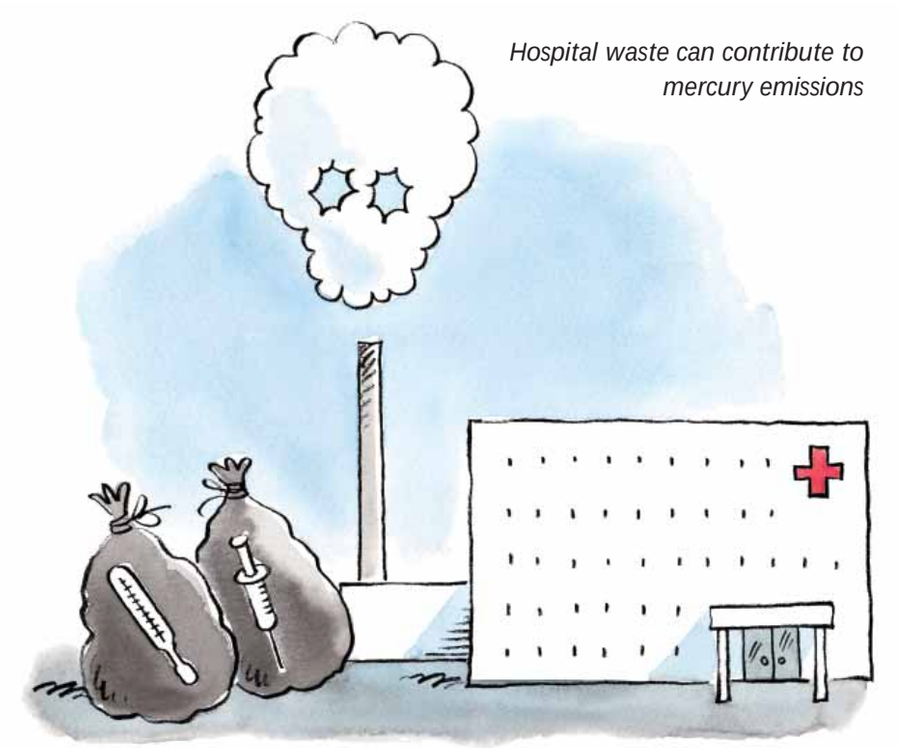
Approximately 70% of environmental mercury now comes from human activities including a variety of industrial processes; coal burning, incineration or disposal of mercury-containing products, the use of mercury for chlorine production in the chlor-alkali industry, production of zinc, steel and other metals; cement production, mining and product recycling.

Mercury is used in a variety of industrial, consumer and medical products.

It is also released into the environment through natural phenomena (volcanoes, degradation of minerals or evaporation from soils) and manmade processes.

PRODUCT EXAMPLES AT A GLANCE[g]:

- fluorescent light bulbs and batteries,
- medical devices: thermometers, blood pressure instruments (sphygmomanometers),
- laboratory chemicals, preservatives in some vaccines and pharmaceuticals, and in dental amalgams[53].
- various temperature and moisture measurement and sensing devices (barometers, hydrometers, flame sensors).



Hospital waste can contribute to mercury emissions

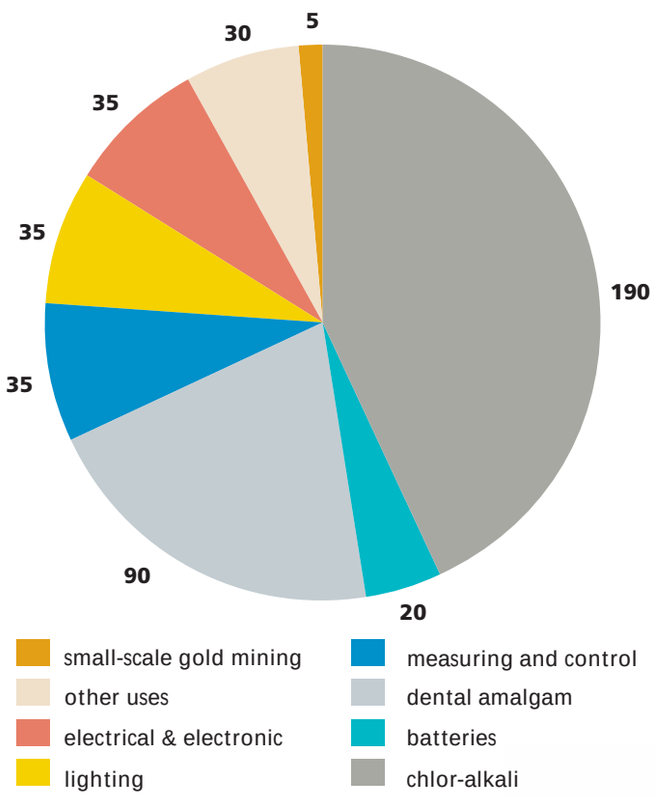
[g] A very detailed list of mercury use in products is available, see: The European Commission, DG Enterprise. **Risks to Health and the Environment Related to the Use of Mercury Products**. Prepared by Risk & Policy Analysts Limited, Norfolk. J372/Merkury. August 2002. Annex 3.

Table 2. USE, EXPOSURE ROUTES AND TOXICITY OF MERCURY AND ITS COMPOUNDS[54] [55]

Mercury Form	Elemental (Hg^o)	Inorganic (mercury salts) (Hg^{1+})	Organic- methyl mercury (CH_3Hg-)	Organic – ethyl mercury (C_2H_5Hg-)	Organic – phenyl mercury (C_6H_5Hg-)
Main Use	Dental fillings (amalgam is a mix of mercury and other metals like Ag, Sn, Cu, In, Zn)	Medicines, Cosmetics (used as a preservative)	No intentional uses, when deposited into water, mercury is transformed into methylmercury by micro organisms and bacteria.	Vaccines (the preservative thimerosal is 49% ethyl mercury	Fungicide, bactericide
Other uses	Goldmining Chloralkali plants Products (batteries, switches, fluorescent bulbs, measuring and control devices eg. thermostats) Medical devices (thermometers, gastrointestinal tubes, sphygmomanometers) Santoria and other ethnic and religious rituals	Disinfectants and anti-microbials Electrical equipment Photography			
Source of exposure	Hospital spills – eg. broken thermometers Dental amalgam Home spills Children playing with quicksilver used in ethnic/ religious rituals		Fish consumption (the fish have ingested methyl mercury and it is in their muscle tissue)		
Route of exposure and absorption rate	Inhalation: 80% absorbed Ingestion: 0.01% absorption Dermal: minimal absorption	Ingestion: ~10% absorbed Dermal: lethal doses can be absorbed	Inhalational: well absorbed Ingestion: 90-100% absorbed	Injection: 100% absorbed	Ingestion: 80-100% absorbed Dermal: see salts
Toxicity - primary	Lungs, Skin, Eyes, Gingiva	Kidneys, Gastro-intestinal tract	Central nervous system	under study	Kidneys
Toxicity - secondary	Central nervous system, Kidneys	Central Nervous system	Cardio-vascular under study		Central nervous system
Transport in body	Crosses blood- brain barrier Crosses the placenta Found in breastmilk	Does not easily enter the brain or cross the placenta	Crosses blood-brain barrier Crosses the placenta Found in breastmilk	Crosses blood-brain barrier Crosses the placenta Found in breastmilk	

NOTE: Dose and Timing of Exposure are not reflected in this table

FIGURE 5.[56] Mercury consumption (tonnes per year) 2005 EU-25



Note: Small-scale gold mining occurs in French Guiana, which is formally part of the EU[57].

How do we use mercury?

In Europe, the largest portion of mercury use is in chlor-alkali plants, with the second largest use being dental amalgam, which uses 90 tonnes annually[58] (see Figure 5). Other important uses of mercury include medical measuring and control equipment such as thermometers, sphygmomanometers[59].

The only remaining mercury mine in Europe – MAYASA in Almaden, Spain – stopped mining in 2003 and is not expected to restart[60] but continues to trade mercury on the open market. Mayasa has an agreement with the EU chlor-alkali industry to buy the surpluses of decommissioned mercury from their plants[61] and resell them. Europe is the dominant exporter of mercury worldwide to the developing world and the net annual export in recent years has been 1000 tonnes[62]. Large amounts of mercury currently circulating on the European market come from decommissioned chlor-alkali plants and from recovered mercury from waste and other sources.

Use of mercury has tripled over last 50 years

CASE STUDY – MERCURY-FREE HOSPITALS

Several EU countries including France (1999), Sweden (1992), Denmark (1994) and the Netherlands (2000) have banned the use of mercury thermometers for consumer as well as healthcare use. Hospitals in Austria, such as the Vienna Hospital Association and Styrian Hospital Association, have voluntarily eliminated mercury thermometers and blood pressure devices from their wards and their purchasing policy prohibits them to procure any products containing mercury.

Mercury elimination efforts are also evolving outside of Europe and other industrialised countries.

In the Philippines, a number of private and public hospitals are moving to eliminate mercury from hospitals and the Philippine Department of Health initiated a nationwide inventory of supplies and costs of existing mercury thermometers and sphygmomanometers in hospitals. The country is moving toward a policy on regulating mercury use and recommending solutions to minimise mercury pollution from healthcare facilities with specific focus on costs and availability of alternatives.

In Latin America, the Buenos Aires City Government in Argentina has committed to transform 33 hospitals into mercury-free facilities. Several other hospitals in the country are moving toward mercury-free health care. Similarly, in Sao Paulo, Brazil, fourteen hospitals have committed to become mercury-free. In Cuba, the government has replaced mercury sphygmomanometers with aneroid devices**.** Four hospitals with 180 to over 600 beds in Delhi, India have switched from mercury containing devices to safer alternatives.

As mercury-based devices are phased out in developed countries, the possible export of medical equipment containing mercury, either for profit or as "charitable" donations, threatens to undermine efforts to make the switch.

"Mercury is in widespread use in health care facilities. Thermometers and sphygmomanometers contain mercury and so do many medical batteries, fluorescent lamps and electrical switches. Mercury compounds are also in preservatives, fixatives and reagents used extensively in hospital laboratories. In soviet time there were regulations on all discharged mercury-containing products, which had to be recycled in an appropriate plant. Currently, no such regulations exist in Armenia."

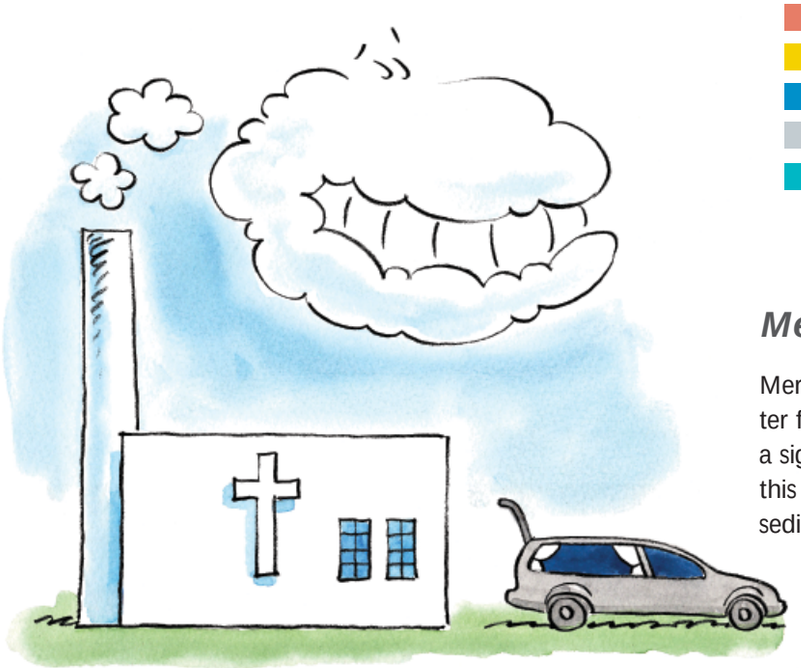
Emma Anakhasyan, The Armenian Women for Health and Healthy Environment, Armenia

Mercury emissions – to air

In the EU, coal combustion is the single largest source of mercury emissions to the air[63], due to the fact that mercury is contained as a trace element in coal. Cement production and waste disposal such as medical and municipal waste incineration are the next most significant sources (see Figure 6). Incinerator ashes and discarded products dumped at landfill sites create another source of potential exposure to soil and water.

"Health-care facilities are one of the main sources of mercury release into the atmosphere because of emissions from the incineration of medical waste." WHO [64]

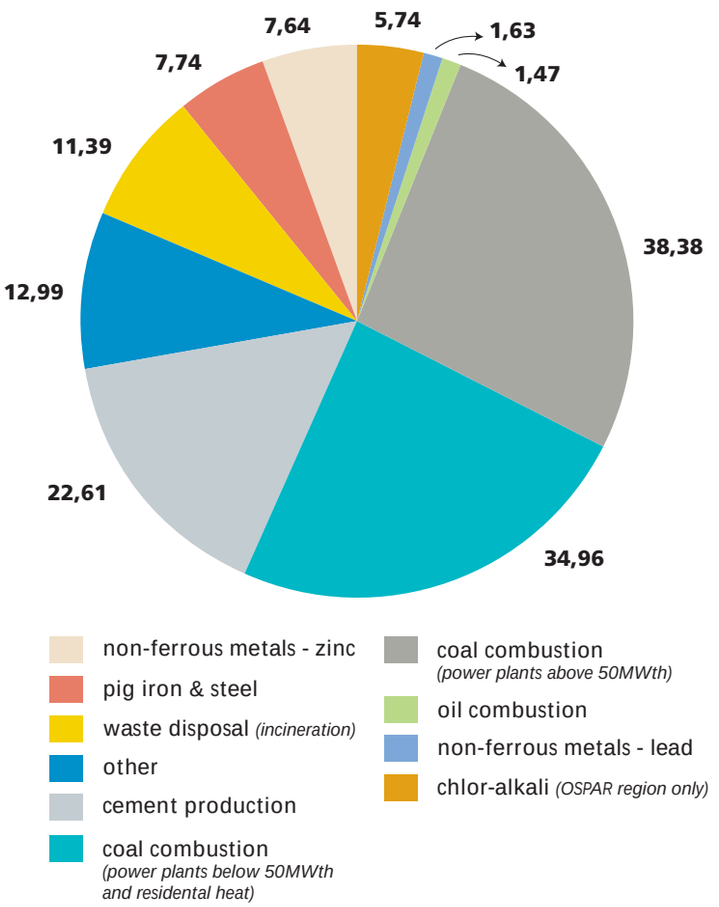
In Europe, emissions from the incineration of hospital waste have declined over the past 5 years due to stricter legislation on pollution prevention (IPPC Directive) and more significantly due to the substitution of mercury measuring devices with safer alternatives in a number of progressive EU countries (Denmark, Austria, Sweden, the Netherlands, France, Germany).



After coal combustion, crematoria are among the most significant contributors of mercury air emissions in Europe

FIGURE 6. Mercury emissions to air in Europe[h] (tonnes per year, 2000 [65]).

Chlor-Alkali (OSPAR region only, as reported by industry)[66].



Mercury emissions – to water

Mercury also enters the environment through discharges to water from various industries. The chlor-alkali industry represents a significant contributor and there is an extensive literature on this subject which shows severe contamination, for example of sediments, fish and marine mammals. Another major source is discharge of dental amalgam waste from dental clinics. Mercury is classified as a priority hazardous substance under the Water Framework Directive[67]. Mercury from various waste streams (used products, landfills, emissions from industrial sources) ends up in the sewage sludge that is used as agricultural fertiliser. If contaminated with mercury, it causes contamination of soil.

[h] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Monaco, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, U.K.

Emissions from health care, including dental amalgam

Dental amalgam represents the second largest use of mercury within the EU after the industrial use of mercury for chlorine production, with 90 tonnes consumed in 2005[68]. It is also a large source of emissions from dental clinics and crematoria; next to coal combustion, crematoria are among the most significant contributors of mercury air emissions in Europe. Furthermore, there is currently no Community legislation to regulate crematoria emissions EU-wide[i].

"According to a report submitted to the OSPAR Commission, in the United Kingdom, annually 7.41 tonnes of mercury from dental amalgam is discharged to sewer, atmosphere or land, with another 11.5 tonnes sent for recycling or disposed with the clinical waste stream. Together, mercury contained in dental amalgam and in laboratory and medical devices, accounts for about 53% of the total mercury emissions[69]." Dental amalgam in crematoria is currently responsible for up to 16% of the UK's air emissions[70] and by 2020 cremation is expected to be the single most significant source of UK mercury emissions[71].

The health effects of mercury used in fillings is still being debated. However, the mercury used in fillings eventually ends up in the environment, either through the sewage system or through incineration (crematoria), and inevitably ends up in the food chain. Many safer alternatives are commercially available and even promoted in some countries like Sweden.

Thermometers are also considered a major source of mercury pollution in waste in Europe, accounting for 80% to 90% of the mercury used in measuring devices (out of 33 tonnes of mercury used in measuring devices)[72].

Mercury in the environment

Mercury enters into the environment in variety of forms. The majority of emissions to air are in the form of gaseous elemental mercury, which can be transported globally to regions far from the emissions source. The remaining emissions are in the form of gaseous inorganic ionic mercury forms (such as mercuric chloride) or bound to emitted particles. These forms have a shorter atmospheric lifetime and will deposit to land or water bodies within roughly 100 to 1,000 kilometres of their source. The ocean currents are also media for long range mercury transport[73].

When mercury is released into the environment from whatever source, it is highly mobile, cycling between the atmosphere and the earth's surface, where it is deposited in soils, water bodies and bottom sediments. In soil and water, microorganisms convert elemental mercury into the more toxic methyl mercury which aquatic plants and animals ingest or absorb. Methyl mercury has the capacity to collect in organisms (bioaccumulate) and to 'biomagnify' as the concentrations increase up each level of the food chain, especially in the aquatic food chain[74].

How does mercury get into fish?

As a transboundary pollutant, mercury can be transported globally to regions far from its source. It has led to contamination of regions with few or no mercury sources, like the Arctic[75]. Sweden for example has been very successful in eliminating most uses of mercury and still the mercury deposition over Sweden is large. The Swedish EPA has estimated deposition at about 4.2 tonnes per annum, most of which comes via long-distance atmospheric transfer, principally from Europe but also from other parts of the world[76].

A further source of mercury (and other persistent organic pollutants) in the future is likely to be the remobilisation of methyl-mercury frozen in ice, due to the melting of the polar and glacial ice resulting from climate change.

[i] Countries that are subject to the OSPAR Convention are recommended to reduce the emissions and a few other EU member states have already implemented similar regulation nationally.

Alternatives to mercury are available

There are various strategies for reducing mercury emissions, the most effective of these involve phasing out the use of mercury in products and industrial processes.

Mercury in health care products

Thermometers Electronic thermometers may be more expensive; however, as glass thermometers often break, they may ultimately be comparable in cost.

Sphygmomanometers Sphygmomanometers are an area of concern because they contain a large amount of mercury per device (80 – 100 g/unit compared to 1 g/unit for thermometers), and therefore pose a greater hazard in the event of a breakage. Both mercury and aneroid sphygmomanometers have been in use for about 100 years. All types of sphygmomanometers require maintenance and calibration to give accurate results. In Sweden, Denmark, Austria and the Netherlands, only positive experiences have been reported from the use of the mercury-free devices[77]. And finally, mercury-free sphygmomanometers can greatly reduce the risk of mercury exposure to patients, staff, and leakage into the environment[j].

Dental amalgam Alternatives to the use of mercury dental amalgams already exist and are being used in some Nordic Member States. It is estimated that less than 6% of all new fillings in Sweden now contain mercury[78]. Replacing mercury as a dental filling material would be far easier and less costly than applying technologies to reduce crematoria emissions from dental amalgams.

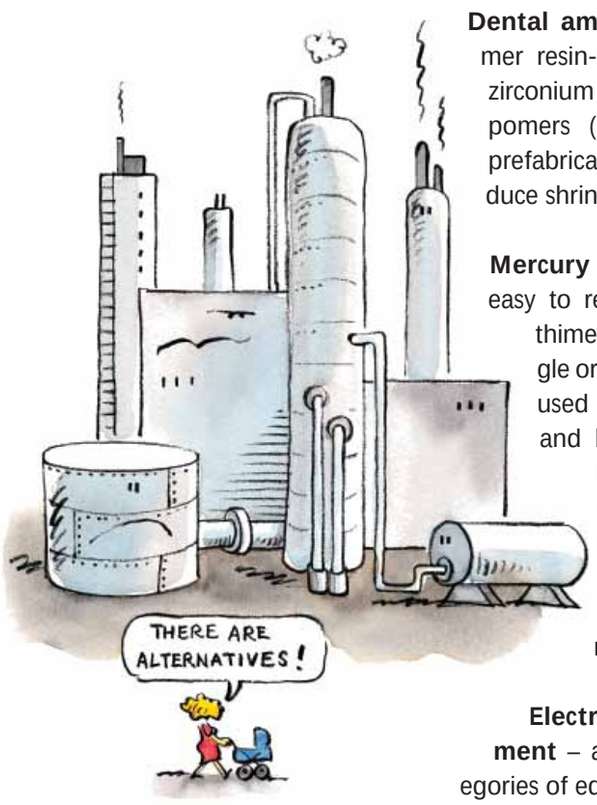
ALTERNATIVES AT A GLANCE

Coal-fired power stations - alternative, renewable means of energy generation; mercury emission control; the use of low mercury coal, coal cleaning or switching to a cleaner fuel[79].

Chlor-alkali plants - diaphragm and membrane technologies.

Thermometers – electronic, glass containing gallium/indium/tin alloy or other liquids such as alcohol.

Sphygmomanometers – aneroid, automated, semi-automated



Dental amalgam - composites (polymer resin-based materials), ceramics, zirconium oxide, glassionomers, compomers (modified composites, and prefabricated ceramic cones, to reduce shrinkage of composite fillings.

Mercury in vaccines - it is relatively easy to replace, reduce or eliminate thimerosal as a preservative in single or multi-dose vaccines that are used in industrialised countries, and both the USA and Europe have begun to take action to phase it out. However, this is harder to do in the Global South because of extra costs and the need for refrigeration.

Electrical and electronic equipment – alternatives exist for all categories of equipment, apart from lamps, where viable substitutes for mercury are currently available for only limited applications[80]

[j] For more information, consult the HCWH fact-sheets on Mercury in Health Care and Substituting Mercury Sphygmomanometers.

"All hospitals and other health care units in Sweden have switched to mercury-free devices. There is a ban in Sweden on purchasing, sale and production of mercury containing thermometers and other measuring devices, including sphygmomanometers (blood pressure meters with inflatable cuff), since 1992. The mercury containing devices were collected and replaced by mercury free devices, as part of every health care organisation's environmental policy. Doctors and nurses find the mercury-free alternatives very acceptable. Nowadays, the young doctors and nurses do not know about anything else."

Ingrid Eckerman, Swedish Doctors for the Environment, Sweden

"I work as a dental assistant eight hours per day. I decided to be tested because I prepare the amalgam fillings. I wear gloves and tell the patients about the risks and their options. Will they have the amalgam or a mercury-free filling that is a bit more expensive?"

Natasa Trajkovska is a 26 year-old dental assistant in Macedonia.