Toxics Link
for a toxics-free world

LURKING MENACE
Mercury in the healthcare sector

The unregulated use of mercury in the healthcare sector and a lack of awareness about its toxic hazards are threatening the wellbeing of the environment and communities

Lurking Menace:
Mercury in the healthcare sector

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Acknowledgement- We would like to thank all the hospitals who have spared their time for us and have taken keen interest to assist us in this research. We would also like to thank all the nurses, hospital administrators, stores managers who took out their valuable time to share and discuss their experiences with us. Our thanks are also due to all the dentists who patiently responded to our queries and gave us insight in this field.

About Toxics Link

Toxics Link is an environmental NGO, dedicated to bringing toxics related information into the public domain, both relating to struggles and problems at the grassroots as well as global information to the local levels. We work with other groups around the country as well as internationally in an understanding that this will help bring the experience of the ground to the fore, and lead to a more meaningful articulation of issues. Toxics Link also engages in on-the ground work especially in areas of municipal, hazardous and medical waste management and food safety among others. We are also involved in a wider range of environmental issues in Delhi and outside as part of a coalition of non-governmental organizations.

Srishti Toxics-Free Health Care Programme, of Toxics Link has the goal of ensuring that responsible toxics free health care practices are followed and safer technologies for medical waste are adopted in the country.

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Executive summary

The country has been working on improving medical waste management for around a decade; and during this long journey it has witnessed many policy changes and a very positive change in the way waste is managed by the healthcare sector.

During this entire process, infectious waste in healthcare establishments (which constitutes around 10% of hospital waste) has been addressed. The remaining 5% (the hazardous portion) now needs to be dealt with. The hospitals which generate hazardous waste have never been made accountable to the Hazardous Waste (Management and Handling) Rules. Even the basic standards for safe use of mercury issued by the Indian Standards Institute are not in place in any hospital.

Mercury, which is used widely in the healthcare sector in thermometers, sphygmomanometers, dental amalgams, laboratory reagents, etc, is a very potent neuro- and nephro-toxic substance. The health impacts of this heavy metal have been widely documented.

In September 2003, Toxics Link released the first report on mercury in India, compiled for the UNEP Global Mercury Assessment. Toxics Link is part of BAN- Hg working group (Basel Action Network and the Mercury Policy Group).

Our report on Mercury usage in healthcare establishments, titled: Lurking Menace: Mercury in the Healthcare Sector, documents the usage of mercury instruments and products in the healthcare sector, the available alternatives and their acceptance, the handling procedures of mercury, its disposal, lackadaisical handling by healthcare staff, etc.

The study done by Toxics Link presents a very grim picture of the way mercury is handled and disposed off by the hospital staff. Mercury equipment breaks very often, but the staff is hardly trained or equipped to deal with any such event. Mercury is handled without any protective gear and is disposed off either with incinerable waste, general waste or via drains, all of which would lead to its entry into the food chain.

Data shows that an average sized hospital can release, conservatively, around 3 kgs of elemental mercury in the environment in an year. With very conservative estimates a city like Delhi would be releasing around 51 kgs of mercury each year through dental practices alone. The city's total release would come from hospitals, dental clinics, crematoriums and laboratories. The problem is compounded as all the generation sources are scattered and non-regulated. Since there are no laws and guidelines governing the releases of mercury no one seems accountable.

The two properties that make mercury extremely unmanageable are bio-accumulation and bio-magnification. Bio-accumulation is the retention of a toxic substance in the tissues, especially muscles. The bio-accumulation factor from water to edible fish tissue exceeds 10 million for certain species of fresh and ocean water fish, thus increasing the potential for mercury poisoning. Nursing infants are the highest in the food chain and can be exposed to dangerously high levels of this element.

Viable alternatives exist for most of the mercury

There is approximately one gram of mercury in a typical fever thermometer. This is enough mercury to contaminate a lake with a surface area of about 20 acres, to the degree that fish would be unsafe to eat

usages, yet, mercury use continues in the country without any regulation. The use of mercury-free products is a cost effective choice when the direct and indirect costs of the products are considered. On the basis of purchase price alone, the cost of mercury-free equipment is generally higher than mercury based products.

However, when other direct and indirect costs are considered, mercury-free equipment is found to be cost-effective for hospitals. Direct costs to hospitals include not only the purchase price but also costs associated with the clean-up of spills, training, storage, disposal and potential health risks to staff, patients, and visitors. Indirect environmental and health costs to the general public and wildlife may also be significant. Small spill clean-ups usually cost around $1000 and large spills can go into the tens of thousand of dollars.

Internationally, there is a shift towards mercury-free alternatives and strict regulations are in place on mercury emissions, but in India mercury in the healthcare sector is hardly a concern for either the policy makers or the sector itself.

There is an urgent need to bring in some policy for gradual shift from mercury equipment to safer alternatives. Healthcare staff needs to be trained to handle this toxic metal safely and the disposal and emission issues need to be addressed.

Section 1: Overview

Mercury is the only metal which is liquid at ordinary temperatures; in fact it is liquid at 298 Kelvin. Mercury is sometimes called quicksilver because of its silvery-white appearance. It rarely occurs free in nature and is found mainly in cinnabar ore (HgS) – in Spain and Italy. It is a heavy, odourless, lustrous liquid metal that sinks in water. It is a rather poor conductor of heat as compared with other metals but is a fair conductor of electricity.

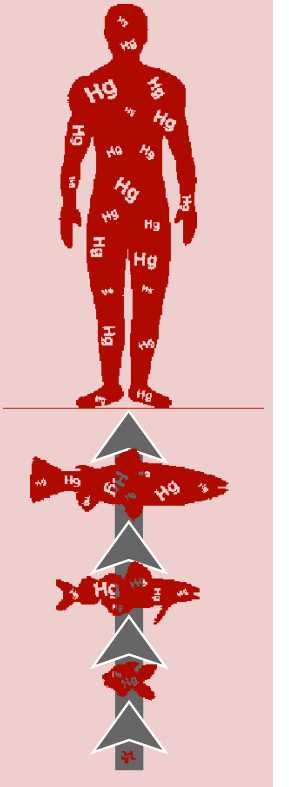
Various industrial processes, and the healthcare sector, use mercury abundantly. If mercury releases are not controlled, it readily escapes into the environment. Mercury can volatilise and enter air and, through air, it can enter water and the soil system. If a liquid effluent contains mercury it can directly deposit it in water and soil. Some bacteria found in soil and water can change mercury to its organic form, which is called methyl mercury, which is then taken in by live forms.

The two properties that make mercury extremely unmanageable are bio-accumulation and bio-magnification. Bio-accumulation is the retention of the toxic substance in the tissues, especially muscles.

Fast facts

- Mercury is the most toxic substance known to mankind.
- Mercury can pass the skin, blood-brain and the placental barrier and cause devastating effects on the functioning and growth of the brain and the growing foetus.
- The most likely routes of exposure are inhalation or absorption of inorganic mercury vapour after a spill or during a manufacturing process, or ingestion of methyl mercury from contaminated fish, etc.
- Mercury can be found in hospitals in products such as thermometers, sphygmomanometers, dilation and feeding tubes, batteries, fluorescent lamps, thermostats, lab chemicals, etc.
- Elemental and inorganic mercury are methylated by bacteria and yeasts in water and soil.
- Amalgam fillings are the largest source of methyl mercury in non-industrially exposed population.
- Mercury vapour from amalgam is the most dangerous form, most rapidly crossing the blood-brain barrier and mother's placenta, and causing adverse developmental effects at lower levels than other forms.[1]
- Mercury can pose a significant health threat when spilled in a small, poorly ventilated room.
- There is approximately one gram of mercury in a typical fever thermometer. This is enough mercury to contaminate a lake with a surface area of about 20 acres, to the degree that fish would be unsafe to eat. Blood pressure equipment has approximately 60 grams of mercury.
- Medical and solid waste that contains mercury or has been contaminated by it is hazardous waste and should be kept out of these waste streams.
- At present, no known treatment exists to reverse the damage caused by this element.

Bio-magnification



The bio-accumulation factor from water to edible fish tissue exceeds 10 million for certain species of fresh and ocean water fish, thus increasing the potential of mercury poisoning. Bio-magnification is the process by which the toxic metal increases in concentration as it moves up the food chain (up to 100,000 times the original levels, in some cases). Nursing infants are the highest in the food chain and can be exposed to dangerously high levels of this element.

Alternatives and laws

Most mercury-containing equipments have a mercury-free alternative. Although some mercury-free alternatives may initially cost more, healthcare organisations often find that their initial capital costs are outweighed by the total costs associated with mercury clean-up equipment, spill costs and liabilities, and handling and disposal costs and liabilities.

Concern about the dangers of atmospheric mercury has been growing since the 1980s. Legislation to address mercury-containing products has been in existence since the early1990s.

There have been lot of national as well as international initiatives to phase-out mercury, especially in the healthcare sector. In 1993, Sweden banned or phased-out the manufacture, import, or sale of thermometers, barometers, manometers, tilt switches, float switches, pressure switches, thermostats, relays, and other types of measuring instruments. Other European countries like Norway and Denmark have banned or restricted the import, sale, and/or use of various mercury containing products. Even in other parts of the world, the gravity of the mercury problem is being realised which has resulted in moving away from it.

Section 2: Research objectives and methodology; findings

Overview

Till now there are no mercury emission standards in the Biomedical Waste (Management & Handling) Rules. Emissions from medical waste incinerators are not tested for mercury levels; mercury is not even tested for in the effluent discharged by hospitals (though there are limits for this heavy metal listed in the standards for water discharged to sewers connected to treatment plants). Mercury is hazardous and is easily accessible to healthcare sector and even households which have limited or zero know-how about the problems with mercury. Once people get exposed to mercury (due to breakage of equipment) they don't even know how to manage it to avoid exposure.

Mercury usage in the healthcare industry is quite high; it is used in thermometers, sphygmomanometers, dental amalgams, some reagents, etc. Despite the fact that safer alternatives to most of these exist, people are still hesitant to use the alternatives. The report tries to understand the resistance to this shift and makes an attempt to change the existing situation.

Objectives

- To document the usage of mercury in the hospitals;
- To understand the risk perception of the healthcare staff with respect to mercury;
- Creating awareness on the hazards of mercury;
- Raise awareness for replacement of mercury with alternate products;
- Advocating for safer work practices for healthcare staff, through formal training, spill clean up mechanisms, gradual phase-out;
- Advocating for a policy on usage, handling, etc, of mercury in healthcare settings and eventual phase-out of mercury products.

Methodology

- Selection of five health care institutions in the city;
- Interview with nurses to gather data on breakage rate of thermometers, sphygmomanometers and other mercury instruments. To study the awareness level in the hospital regarding spill management;
- Interview with purchasing units of the health care establishments to study the difference between the cost of digital and mercury equipments, procurement information and breakage rates;
- Conversation with manufacturers, dealers and retailers about taking back of mercury collected from the hospitals, market trends, etc;
- Survey of dental clinics to explore reasons for use of amalgam/alternative for dental fillings. And also, cost difference between non-mercury fillings and mercury amalgams fillings, experiences with all types of fillings, using questionnaires and through conducting interviews.

The Toxics Link team contacted some reputed hospitals and dentists in New Delhi for carrying out the study A volunteer assisted us in the study by studying select hospitals in Patna. In New Delhi, five private hospitals were visited as part of this survey. All of them were following improved bio-medical waste management practices and segregating waste. Waste was being disposed off through common bio-medical treatment facilities.

Different areas of the hospitals were covered.

Nursing Station was one of our main information points as nurses are the ones who deal with the mercury containing instruments. We spoke to about 100 nurses in various age groups and with varied experiences. Four hospitals out of the five sampled have nursing schools attached to them and hence there are lot of nursing students in the wards at all times.

The team also contacted some reputed hospitals and dentists in Patna for carrying out a preliminary study. Seven hospitals and 12 dentists were visited as part of this survey. Eighty four hospital staff were interviewed.

Though the hospitals we went to use several mercury containing instruments, our focus has been on thermometers and sphygmomanometers as these are most commonly used.

Main findings

Thermometer

- The maintenance department of hospitals checks all thermometers of the hospital once in a while. As the mercury thermometers cannot be calibrated, the defective ones are discarded in the trash. There is no policy on disposal of this waste.
- Most of the healthcare staff discards broken thermometers with glass waste, since, to them, the broken glass is the major hazard, rather than the mercury.
- Hospitals having nursing schools attached to them, register more breakage rate, this can be attributed to lack of experience. With experience, breakage rate reduces.
- One of the reasons mentioned for breakage of clinical thermometers is that they are kept in a glass bottle and the thermometer breaks while putting it in the bottle. They have to be extra careful as the glass bottles have a hard bottom. One of the hospitals has replaced glass bottles with plastic ones.
- Mercury thermometer breakage is never handled carefully. Some of the major ways in which spills are handled are: sweeping it down the drain; collecting it in a container and discarding it with general waste; collecting and putting in yellow bags (a rarity). Only some people collect and store mercury. St. Stephens hospital collected around 1.6 kgs of mercury over the past 2 years (since last year they have switched over to digital thermometers) and sold it to a recycler.
- Average monthly breakage rate of thermometers in a 300-bedded hospital is around 70.

Sphygmomanometers

- Most hospitals calibrate the BP apparatus in-house. The maintenance department does this in most cases, and generally the person doing it has adopted methods used by his/her predecessor. It's without any formal training or know-how about the methods of calibration or the hazards of mercury. According to some experts the mercury vapour level in such calibration rooms is much higher than the permissible limits.
- One hospital encased its BP machines and found that the breakage rate came down. On removal of the case, the breakage rate went up again.
- Nurses find it difficult to read the meniscus exactly, thus they have a practice of rounding of the figure to the nearest big mark.
- Manual techniques may suffer from observer bias. Differences in auditory acuity between observers may lead to consistent bias.

Dental Fillings

- People doing composites observed that amalgam fails at the aesthetic front, because of poor colour matching. Amalgam is not possible in the cavities of the anterior teeth. Even at the posterior end, aesthetically mercury is a poor choice over alternatives, which offer very good colour matching.

Around 89% of the nurses interviewed were aware of the hazards of Mercury; only 60% follow some safety guidelines in case of a spill, and only about 18% follow the correct procedure.

- Mercury tends to vapourize from the amalgam and gets impregnated in the gums. After few years some patients might develop a white silvery line on their gums, called 'amalgam tattoo'. This, according to some researchers, proves that there is mercury release from dental amalgams.
- Initially, there were problems of sensitisation with the composite fillings, but now since people have started giving liners, this problem has been solved.
- Earlier, patients frequently came back with fractured fillings in case of composites. But over the last few years the quality has improved and both dentists and patients are not facing such problems, and have developed confidence in these alternates.
- Composite fillings cost double than their amalgam counterparts and thus cost is the major factor, which influences the type of filling. But because composites are aesthetically better there is an obvious inclination towards these in middle- and upper-middle-class locations and vice versa in the lower income group.
- Children are generally given a 'miracle mix' – glass anomer fillings – to avoid mercury toxicity.
- No protective gear is worn while handling mercury in the dental procedures.
- Most young dentists say they prefer doing a composite filling.

Occupational Safety

- The healthcare staff knows about the toxicity of mercury, but the gravity of danger is not appreciated by most. The general perception is that the amount found and used in the healthcare sector is too low to cause any harm.
- Around 89% of the nurses interviewed were aware of the hazards of mercury; only 60% followed some safety guidelines in case of a spill. Only about 18% followed the correct procedure.
- In hospitals most people do not wear any protective gear while handling mercury.
- In the process of preparing amalgam in the dental sector, no protective gear is worn. When silver powder is mixed with mercury liquid, a solidified mix is formed, which is then put in a gauze piece and strained manually to squeeze out excess mercury (called squeezing). Then this material is taken in palms and rubbed to get a uniform mix without any air bubbles (process is called mulling). This is generally done by dental assistants who are not aware of the hazards of mercury handling. Dentists admit that even after knowing the hazards they themselves sometimes avoid using protective gear. Amalgamators are available for preparing amalgams and avoid any undue exposure, but still manual mixing is done.
- Most dentists recalled that as students they have witnessed many mercury spills.
- Mercury reacts with gold and silver jewellery to form amalgams; lot of nurses have experienced this phenomenon and thus are very careful about their jewellery before dealing with mercury.
- A nurse had experimented with reversing the process of amalgamation by heating her bangles, and till date she thinks that she was successful to some extent, oblivious of the fact that she narrowly escaped death. Mercury has a very high vapour pressure and on heating mercury, (especially in closed, badly ventilated room) the mercury vapour released can be

enough to cause death by inhalation.

- People involved in calibrating mercury thermometers can be at high risk of mercury exposure, because most of them do this without protective gear and the method involves higher levels of mercury vapours and more exposure time.
- No documented cases exist for occupational mercury exposure in India. The reason is not non-existence of such cases, but simply the ignorance about the hazards of mercury. People are not aware of the hazards of mercury (long- and short-term), thus even if they might experience some of them, they might not be able to relate it to mercury.

Release of mercury from various sources

- As much as 9,216 grams of contact amalgam waste may be generated each year in Delhi. It is estimated that 4,608 grams of contact amalgam goes into waste each year (50% of contact amalgam generated) and the same amount may be going to the drain.
- Findings of a study on wastage of mercury from dental clinics, applied to the Delhi context suggest – the minimum and the maximum amount of non-contact amalgam generated each year could approximate 7.3 kgs to 76.8kgs each year (see table below).
- Delhi may be generating around 51 kgs of mercury from amalgams each year, which is thrown in the general bins or drained into sewers.
- An average sized hospital in Delhi may record a breakage rate of 70 thermometers in a month and thus contribute to around 840 gms mercury contamination per year through thermometers alone. Taking into account BP apparatus and assuming a leakage of only 1/3 rd of the total amount of mercury in it (60 gms), and assuming 2 BP spills in a month, around 480 gms of mercury may be wasted. Considering mercury wastage of a hospital only due to thermometers and sphygmomanometers, and ignoring all other sources, a hospital is accountable for an environmental mercury burden of 1,320 gms/year. Similar hospital with a dental wing may release 2.8 kgs of mercury.
- Some of the dentists interviewed do collect the residual amalgam or mercury separately. As there are no regulations regarding this, they are clueless about its proper disposal. The waste keeps lying in some dental offices for long periods and eventually gets thrown in municipal waste.

Percentage of amalgam filling	Average number of placements per week	Grams of Hg waste/year (from non-contact amalgam)
15%	8	7,372.80
50%	25	76,800.00

Section Three: Sources of mercury

There are a number of ways by which mercury enters our environment, some are natural but most are the result of human activity.

Industrial uses and consumer products containing mercury can be significant sources of mercury release into the environment. Air emissions from coal-burning power plants, trash incinerators, medical waste incinerators and hazardous waste combustors are major contributors of mercury.

But not all mercury comes from emissions into the air. It can also come directly from such sources as municipal and industrial sites, hospitals, dental office wastewater or the breakage or disposal of mercury-containing products such as fluorescent lights, thermostats and thermometers.

Either way, once the mercury is in soil or in a lake, pond, or stream, it can be transformed to its most toxic form – methyl mercury – which builds up in fish and animals that eat fish.

There is clear evidence that mercury impacts on the environment have considerably increased globally due to human activities.

Major sources of anthropogenic releases of mercury

From mobilisation of mercury impurities

- Coal-fired power and heat production (largest single source to atmospheric emissions)
- Energy production from other fossil carbon fuels
- Cement production (mercury in lime)
- Mining and other metallurgic activities involving the extraction and processing of virgin and recycling mineral materials, for example production of iron and steel, ferromanganese, zinc, other non-ferrous metals
- Petroleum production

From intentional extraction and use of mercury

- Mercury mining
- Small-scale gold mining(amalgamation process)
- Chlor-alkali production
- Use of fluorescent lamps, instruments, dental amalgam fillings etc.
- Manufacturing of products containing mercury, for example: thermometers, manometers and other instruments, electrical and electronic switches
- Biocides, for example, seed-dressing, pesticides and slimicides
- Use of other products, such as batteries, fireworks and laboratory chemicals

From waste treatment, cremation, etc. (originating from both impurities and intentional use of mercury)

- Waste incineration (municipal, medical and hazardous wastes)
- Landfills
- Cremation
- Cemeteries (release to soil)
- Recycling and storage

Contamination in India

Although it is well recognised that mercury is widespread in the Indian environment, and that

Recent evidence shows that exposure to mercury is widespread among the Indian population and occurs at levels exceeding health-based recommended value

exposure occurs primarily through consumption of fish, information about its distribution in blood system and hair mercury levels in general Indian population is lacking.

Hence it has become difficult to fully evaluate the public health significance of the mercury problem. Recent evidence shows that exposure to mercury among the Indian population is widespread and occurs at levels exceeding health-based recommended value. India's population was unaware of mercury hazards for the last few decades. Due to the global scenario, the awareness regarding hazards caused by mercury pollution is increasing among Indians.

Environmental Load

The presence of mercury in the environment (air, water and land) in India can be traced back to the 1970s, when various studies conducted showed the presence of mercury in our environmental bodies.

Water

Both surface and ground water have become increasingly contaminated with wastes and pollutants from industry, agriculture and household. Over the years, water pollution has increased the concentration of mercury in Indian waters. Ground water provides about 80 per cent of drinking water needs in India. A 1999 study tested and analysed ground water samples from eight places in three states – Gujarat, Andhra Pradesh and Haryana. The results are shocking: the mercury levels found were dangerously high in all the samples.

The River Ganga

From 1986 to 1992 water samples were regularly collected each month from 20 different locations. The concentration levels of mercury in the river Ganga was found to be as high as 0.1 mg/l.

From 1986 to 1992, water samples were regularly collected each month from the seven major tributaries of the river Ganga and analysed for different metals levels. Concentration levels of mercury are given in the table below.

Mercury in Ganga's tributaries

Tributary name	Mercury (in mg/l)
Gomti (Udyarghat)	0.003
Gandak (Patna)	0.02
Ghaghra (Saran)	0.06
Kalinadi (Kannauj)	Not detectable
Ramganga (Kannauj)	0.02
Yamuna (Allahabad)	0.10
Son (Koelwar)	0.05
Hugli estuary water	0.29

Section 4: Mercury usage and alternatives in the healthcare sector

Mercury or mercury compounds are found in many instruments regularly used in medical institutions such as blood pressure monitors, dental amalgam, thermometers and thermostats. Mercury and mercury-containing products are used in patient areas and pathology labs, in clinical procedures, and in medicines and vaccines.

But now majority of products that use mercury purposefully have safer alternatives.

The use of mercury free products is a cost-effective choice when the direct and indirect costs of the products are considered. On the basis of purchase price alone, the cost of mercury free equipment is generally higher than mercury-based products. However, when other direct and indirect costs are considered, mercury-free equipment was found to be cost-effective for hospitals. Direct costs to hospitals include not only purchase price but also costs associated with clean-up of spills, training, storage, disposal and potential health risks to staff, patients, and visitors. Indirect environmental and health costs to the general public and wildlife may also be significant.

A typical thermometer contains ½ to 3 grams of mercury. A typical household mercury fever thermometer contains approximately one gram and a typical barometer contains 454 grams of mercury. The cost of cleaning up a spill will vary by the size of the spill and the degree of exposure of property and people. Small spill clean-ups usually cost around $1000 and large spills can go into the tens of thousand of dollars.[2]

Thermometers

Thermometers measure temperature, by using materials that respond in some way when they are heated or cooled. There are many different thermometers relying on different principles.

How accurate are mercury thermometers?

In a study done by CERC, around 15 brands of mercury thermometers were tested for different parameters including accuracy. According to the study, published in *Insight*, the consumer magazine (July 2000), all of them recorded inaccurate temperature. This clearly shows that the mercury thermometer, which is considered as a golden standard, may not actually be so.

Alternatives to mercury thermometers

Several types of non-mercury thermometers are available commercially. These include:

- Digital electronic thermometers
- Glass alcohol thermometers

Digital electronic thermometers: It is now common to measure temperature with an electronic thermometer which functions with the help of some in-built sensors.

Glass alcohol thermometers: These thermometers use the same principle as mercury thermometers though the mercury is replaced by red coloured alcohol.

The American Medical Association recently re-

viewed the benefits and drawbacks of the more readily available types of fever thermometers. According to them, both glass mercury thermometers and digital thermometers give an accurate reading. But the digital thermometers offer the advantage of ease of use and reading.

International initiatives to move away from mercury thermometers

- **Norway:** There are prohibitions against production, import, export and sale of Hg thermometers. Old thermometers are considered hazardous waste and have to be delivered to hazardous waste facilities.
- **Sweden:** The import, professional manufacture and sale of clinical mercury thermometers was prohibited from January 1992.
- **USA:** Several states of USA have banned the use of mercury fever thermometers, and most major retailers do not sell them.
- **Denmark:** There is a general ban on sale of mercury containing thermometers. Exemptions from this ban are primary EU approved thermometers.

Sphygmomanometer

Blood pressure is the result of the activity of the heart and blood vessel system and is widely accepted as a measure of cardiovascular performance. Therefore blood pressure levels and variations are considered to be an indicator of cardiovascular function and overall health. Sphygmomanometers are the commonest form of blood pressure measuring apparatus used in every clinic and every ward of hospitals.

Most blood pressure devices use an air-filled cuff to temporarily block blood flow through the artery, then apply a particular technique to obtain blood pressure data while the cuff deflates. The two most common techniques for pressure measurement are the auscultatory method (listening for characteristic blood flow sounds) or oscillometric technique (using a pressure transducer).

Some major findings on mercury thermometers from the study:

- Hospitals having nursing schools attached to them, register a very high breakage rate (5-6 per ward/month).
- A major reason of breakage of clinical thermometers in wards is the instrument slipping out of the hand while shaking it to bring the temperature down.
- Another reason mentioned for breakage is that it is kept in a glass bottle and when they are putting it in, it hits the hard bottom and breaks. One of the hospitals has replaced the glass bottles with plastic ones and has found that the breakage rate has decreased.
- Mercury thermometer breakage is never handled carefully. Some of the major ways in which spills are handled are: sweeping it down the drain, collecting it in a container and discarding it in general waste.
- Average monthly breakage rate of thermometers in a 300-bedded hospital is around 70.

Mercury sphygmomanometer

This is the commonest form of blood pressure measuring apparatus. The measurement is indirect (that is, there is no sensor inside the body) and is subjective, and therefore can result in large errors, particularly if the operator is inexperienced.

Alternatives to mercury sphygmomanometer

The two most common alternates to the mercury blood sphygmomanometer are:

- Aneroid
- Electronic

Dental amalgam

Dental amalgam is the most commonly used dental filling material. Dental amalgam is a mixture of mercury and a metal alloy. The normal composition is 45-55% mercury; approximately 30% silver, and other metals such as copper, tin and zinc.

Fundamental health flaws[3]

A 'silver filling' is a euphemism for an amalgam restoration which a dentist places in a patient's tooth after a cavity is created by drilling out decay.

The dental amalgam has two fundamental flaws that adversely effect a patient's health. The first fundamental flaw is that all amalgam metals are cations[4]. The net result of the tendency for covalent, ionic and metallic bonding and Van der Waals forces[5] between amalgam cations is a weak repulsion. So there is a sustained release of mercury and other metals from the amalgam into the body. Researchers have measured a daily release of mercury on the order of 10 micrograms from the amalgam into the body. Mercury is a toxic metal; the most minute amount damages cells.

The second fundamental flaw is that there are five dissimilar metals in the amalgam. Galvanic action[6] between these metals in inevitable (the dissimilar metals form a battery). Galvanism produces electricity that flows through the body. The electric currents produced by the amalgam typically are between 0.1 and 10 microamps, compared to the body's natural electric current of 3 microamps.

A large dental amalgam may contain more than 750 mg of elemental mercury. Toxicity Characteristic Leaching Procedure (TCLP) tests have shown that amalgam can exhibit characteristic toxicity for mercury. After placement of a mercury/silver dental amalgam there is a persistent, low level release of elemental mercury vapour into

Sphygmomanometer efficacy

In reality, mercury and aneroid sphygmomanometers are widely used because of their low purchase price. When both units are in proper working order, either will give acceptable results. Both styles require calibration checks at regular intervals (at least annually). For aneroid devices, the procedure requires adjusting calibration at several pressure points, not just at zero like a mercury device.

Although simpler to calibrate, mercury sphygmomanometers have some inherent disadvantages when compared with the aneroid sphygmomanometer.

- Mercury is a toxic substance that threatens humans and wildlife. As a result, spills require careful and costly cleanups.
- It requires excellent technique to read the meniscus of a mercury column.
- Maintenance of mercury devices is cumbersome.
- Each mercury sphygmomanometer has a vent or filter allowing outside air to be drawn in. Without frequent filter replacement, the mercury column experiences lag. "Lag" is a delay in the mercury response, which may result in an inaccurate reading.
- Most hospitals calibrate the BP apparatus in-house. It's done without any formal training on the know-how about the methods of calibration or the hazards of mercury. According to some experts, the mercury vapour level in such calibration rooms is much higher than the permissible limits.

Scientific research has proven that the corrosion of dental amalgams by chewing, exposure to oxygen in breathed air, food acids causes the continual release of elemental mercury vapour into the body 24 hours a day

the body for many years thereafter. Scientific research has proven that the corrosion of dental amalgams by chewing, exposure to oxygen in breathed air, food acids causes the continual release of elemental mercury vapour into the body 24 hours a day and the uptake of inorganic mercury in swallowed saliva that exceeds known standards of exposure by 10 to 100 times.

Moreover, in 1991, the World Health Organization confirmed that dental amalgam is the greatest source of mercury vapour in the non-industrially exposed population, significantly exceeding that from food or air.

The Lorschieder-Vimy experiments[7]

The most crucial research in the saga of dental amalgams began in 1983, when a Canadian dentist, Murray Vimy became curious about the stability of the mercury in amalgam fillings. The resulting readings were high enough to be troubling. In 1985 Lorscheider and Vimy demonstrated unequivocally that mercury vapour is continuously released from amalgam fillings in measurable quantities. The researchers also observed that brushing the teeth with commercial toothpaste stimulated the release of vapour from amalgam surfaces, at approximately the same higher rate as gum-chewing and for the same time periods.

Next, Lorscheider and Vimy decided to try to find out whether the mercury vapour from the fillings was taken into the body, and if it was, to see what happened to it there. For this experiment, their team used dental amalgam made with the normal ingredients and proportions, but with mercury that was radioactively tagged (203Hg) in sheep which was then repeated in monkeys.

The X-ray pictures showed that the radioactively tagged mercury from the fillings was present everywhere in the sheeps' bodies. It was found in the heaviest concentrations in the gastrointestinal tract, and next in the kidneys, liver, and brain. Heavy concentrations were also found in the jawbones, the gum tissues and the lining of the trachea.

Alternatives to mercury amalgams

Dental restorations can be classified into two types. Inserting filling material directly into the tooth comprises direct restorations. Indirect restorations are fabricated outside of the mouth.

In recent years, there has been a marked increase in the development of aesthetic materials made of ceramic and plastic. These mimic the appearance of natural teeth and are more aesthetically pleasing.

Initially, amalgam fillings faired better over composite restorations, however, recent advances in particle formulation and shape have made the newest posterior composites quite competitive for filling back teeth. Composites are stronger than amalgams in tensile strength which makes them better for overlaying large biting areas. As the materials continue to improve, they have become tougher and more wear resistant while improvements in placement technique have reduced cold sensitivity. The technology involved in composite formulations has made tremendous strides in improving the wear, strength, appearance, setting

characteristics, water miscibility, and numerous other less obvious qualities. They continue to improve yearly. The newest generation of composite filling materials has finally overcome most of these difficulties, which prevented their widespread use in restoring back teeth.

Waste disposal

Hospitals are one of the major contributors of mercury in the waste streams. A number of products that become part of the solid waste stream contain mercury, including certain thermometers, fluorescent lamps, button batteries, thermostats, manometers, switches, relays, and dental supplies. If these wastes are disposed off with our regular trash then the mercury can contaminate our environment.

Breakage, spills and waste disposal from these products release mercury to the atmosphere or to drains, where it can persist for many years. Wastewater streams emanating from hospitals often show a higher than expected level of mercury. In a mercury reduction programme in Massachusetts, 28 hospitals reduced the annual mercury concentration of their waste water from an overall average of approximately 23 µg/l (ppb) to as low as 6 µg/l.

Incinerators are the fourth-largest source of mercury emissions into the atmosphere. This mercury can travel anywhere – from a few hundred feet to thousands of miles away from its original source.

Mercury clean-up guidelines

- Immediately after a spill keep all people and pets away from the spill area. To minimise the mercury that vapourises, turn off any heaters and turn up any air conditioners. Ventilate the area by opening windows and, when possible, keep open for at least two days.
- Never use a vacuum cleaner to clean up a mercury spill. Not only will the mercury contaminate your vacuum cleaner, the heat from the vacuum cleaner will evaporate the mercury, further distributing it throughout the house. Similarly, never use a broom to clean up mercury. It will only distribute the mercury into smaller beads, and will contaminate the broom.
- Care must be taken not to touch the mercury.
- Assemble the necessary supplies before attempting a clean up. These include gloves, eye protection, an eyedropper or a syringe, and two stiff pieces of paper or cardboard, two plas-

Some major findings about amalgams

- Mercury tends to vapourise from the amalgam and gets impregnated in the gums. After few years some patients might develop a white silvery line on their gums, called 'amalgam tattoo.'
- In the process of preparing amalgams, generally no protective gear is worn.
- Delhi may be generating around 51 kgs of mercury from amalgams each year, which is thrown in the general bins or drained into sewers.
- Many dentists have switched over to composites mainly because of aesthetic reasons and feel that composites have improved tremendously over the last two years making them as competent as mercury.
- Most young doctors felt that given a choice they would prefer doing composites rather than amalgam, but the senior doctors said otherwise.
- Some dentists felt the need of having a collection mechanism for their hazardous amalgam waste
- Most of them recalled being witness to spill and careless handling of elemental mercury as dental students.

tic bags, a large tray or box, duct tape or packing tape, a flashlight and a wide mouth container. Remember that any tools used for clean up should be considered contaminated and disposed of with the mercury.

- Remove all jewellery and watches from your hands, as mercury will bond with the metal. Put on gloves, preferably rubber gloves to minimise contact with mercury. Use the flashlight to locate the mercury.
- On a hard surface or tightly woven fabric, use stiff paper to push beads of mercury together. Use the eyedropper to suction the beads, or working over the tray to catch any spills, lift the beads of mercury with the stiff paper. Carefully place the mercury in a wide mouth container. Pick up any remaining beads of mercury with sticky tape and place contaminated tape in a plastic bag along with the eyedropper, stiff paper, and gloves. Label the bag as mercury waste. Place this bag and sealed container in the second bag. Label it as mercury waste.

Some major findings about waste disposal

- Delhi may be generating around 51kgs of mercury from amalgams each year, which is thrown in the general bins or drained into sewers.
- An average sized hospital in Delhi with a dental wing could be generating around 3 kgs of mercury waste.
- Some of the dentists interviewed do collect the residual amalgam or mercury separately. But as there are no regulations regarding this waste disposal; it eventually gets thrown in municipal waste.

Section 5: Health impacts of mercury

Mercury is very toxic and it may be fatal if inhaled and harmful if absorbed through the skin. It may cause harmful effects on the nervous, digestive and respiratory systems, and the kidneys. Mercury may also cause lung injury – effects may be delayed. Mercury is corrosive to some metals. It is a skin sensitiser – it may cause allergic skin reaction, and it is a reproductive hazard – may cause behavioural effects, based on animal information.

Exposure to mercury

Exposure to mercury can happen through:

- Eating fish contaminated with methyl mercury.
- Breathing vapours in air from spills, incinerators, and industries that burn mercury-containing fuels
- Release of mercury from dental and medical treatments
- Breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury)
- From a pregnant woman/ nursing mother to their child

Short-term exposure to high concentrations of mercury vapour can cause harmful effects on the nervous, digestive and respiratory systems, and the kidneys. This type of exposure may occur when mercury is heated.

Initial exposure to high concentrations of mercury vapour produces symptoms similar to 'metal fume fever' including fatigue, fever, and chills. Respiratory system effects include cough, shortness of breath, tightness and burning pains in the chest and inflammation of the lungs.

Occupational exposure to 1 to 44 mg/m^3 of mercury vapour for 4 to 8 hours causes chest pain, cough, coughing up blood, impaired lung function and inflammation of the lungs. In some cases, a potentially life-threatening accumulation of fluid in the lungs (pulmonary edema) has occurred. Exposure to high, but unspecified, concentrations of mercury vapour has caused death due to respiratory failure. All of the reported deaths resulted from inhaling mercury vapours formed by heating mercury.

Several case reports have described harmful nervous system effects following inhalation of high concentrations of mercury vapour. The most prominent symptoms include tremors (initially affecting the hands and sometimes spreading to other parts of the body), emotional instability (including irritability, excessive shyness, a loss of confidence and nervousness), sleeplessness, memory loss, muscle weakness, headaches, slow reflexes and a loss of feeling or numbness.

A classic sign of exposure to high concentrations of mercury is inflammation of the inside of the mouth (stomatitis), sometimes with a metallic taste, excessive salivation and difficulty in swallowing. Other digestive system effects include abdominal pains, nausea, vomiting and diarrhoea.

Kidney injury is common following exposure to high concentrations of mercury. Reported effects range from increased protein in the urine to kidney failure. Exposure to high concentrations of mercury has also caused increased blood pressure and heart rate.

During pregnancy, mercury passes readily through the placenta; the concentration in cord blood is elevated above the level of the maternal blood. There is therefore a risk to the foetus in chronically exposed pregnant women

Long-term health effects of exposure to mercury

The harmful effects of long-term exposure to elemental mercury are generally thought to be caused by inhalation exposure. However, mercury liquid and vapour are absorbed through the skin in small amounts and this route of exposure can contribute to the overall exposure. Effects following absorption through the skin are expected to be similar to those reported for long-term inhalation exposure.

- **Effects on the nervous system:** Effects on muscle coordination, mood, behaviour, memory, feeling and nerve conduction have been reported following long-term occupational exposure to mercury.
- **Effects on the kidney:** Many occupational studies indicate that moderate to high exposure to mercury can cause harmful effects on the kidneys. Early indicators of kidney injury include increased levels of protein in the urine (proteinuria) and increased levels of certain enzymes in the blood and urine.
- **Skin sensitisation:** Allergic skin sensitization has been reported in people with occupational exposure to mercury liquid or vapour. Once a person is sensitised to a chemical, contact with even a small amount causes outbreaks of dermatitis with symptoms such as skin redness, itching, rash and swelling.

Mercury and reproductive health

Chronic mercury exposure can seriously impair fertility and the outcome of pregnancy. In one study 45 women dentists and 31 dental nurses were questioned about their reproductive history and hair samples were taken to estimate mercury exposure. A positive association was found between elevated mercury levels and incidence of malformations and aborted pregnancies.[8]

During pregnancy, mercury passes readily through the placenta; the concentration in cord blood is elevated above the level of the maternal blood. There is therefore a risk to the foetus in chronically exposed pregnant women. The World Health Organisation stated in 1991 that 'the exposure of women in child-bearing age should be as low as possible'.

In men, organic forms of mercury were found to cause hypospermia, a reduction in libido and impotence in some subjects. Evidence of minor genetic damage (aneuploidy) was found, thought to be caused by interference of the metal with thiol groups in the spindle apparatus of dividing cells.

Workplace exposure limits

Elemental mercury (mercury zero) is a liquid and gives off mercury vapour at room temperature. Its vapour pressure is sufficiently high to yield hazardous concentrations of vapour at temperatures normally encountered both indoors and outdoors under most climatic conditions. For example, at 24° C, a saturated atmosphere of mercury vapour would contain approximately 18 mg/m^3 – a level of mercury 360 times greater than the average permissible concentration of 0.05 mg/m^3 recommended for occupational exposure by the National Institutes of Safety and Health, USA (NIOSH, 1973).

These exposure limits are for air levels only. When

skin contact also occurs, a worker may be overexposed even if air levels are less than the limits listed above.

People working around mercury should wear protective clothing and gloves along with mercury respirators that prevent them from breathing in mercury vapour. If you have people who are constantly exposed to mercury, they should be tested regularly to make sure that they are not suffering any health effects due to the exposure.

Mercury build-up or accumulation in the body

The mercury vapour is well absorbed following inhalation. Elemental mercury is excreted from the body slowly. It has an elimination half-life of 40-60 days. Most elemental mercury is excreted in exhaled air, and small amounts in the faeces and urine. Very small amounts are eliminated in sweat, saliva and milk. Following ingestion, elemental mercury is poorly absorbed and most of it is excreted in the faeces. Elemental mercury liquid and vapour can be absorbed through the skin in small amounts. Elemental mercury is transferred to the developing child in pregnant women.

Measurement of mercury in the body

Mercury and other toxic heavy metals are primarily measured in hair, blood cells and urine samples. By far, the most accurate, practical, clinical measurement of the relative total body burden of mercury is obtained through a provocative, 24-hour elemental urine analysis. In this procedure, a dose of Dimercaptosuccinic Acid(DMSA) and glycine is taken the evening before the urine test, thereby extracting mercury and other toxic heavy metals from their hiding places in the tissues, which is then collected in the urine, thus giving a more accurate measure of total body burden.

Minimising exposure to mercury

People dealing with this chemical should be properly trained regarding its hazards and its safe use. Maintenance and emergency personnel should be advised of potential hazards.

Unprotected persons should avoid all contact with this chemical including contaminated equipment. Immediately report leaks, spills or ventilation failures. Avoid generating vapours or mists. Avoid using mercury equipment wherever possible. When handling large quantities, closed handling systems should be used. Never heat mercury. If at all it has to be done, it should be done in a conrolled system.

Do not use with incompatible materials such as strong oxidizing agents (e.g. chlorine dioxide). Never return contaminated material to its original container.

Use the type of container recommended by the manufacturer. Metals that have good or excellent resistance to corrosion by amalgamation include iron, steel, stainless steel, nickel and molybdenum. Inspect containers for leaks before handling. Secondary protective containers must be used when this material is being carried. Label containers. Avoid damaging containers. Keep containers tightly closed when not in use. Assume that empty containers contain residues, which are hazardous. Use corrosion-resistant transfer equipment when dispensing. Whenever possible use self-closing, portable containers for dispensing small amounts of this material.

Never transfer liquid by pressurizing original container with air or inert gas. Good housekeeping is very important. Immediate and complete cleanup of spills is necessary. Do not use on porous work surfaces (for example, wood). Use work surfaces that can be easily decontaminated.

6

Section 6: Mercury trade in India

Mercury is not extracted in India; it is totally imported. Mercury and mercury containing wastes are included in the waste streams of the Basel Convention on transboundary movements of hazardous waste and their disposal.

In order to control the movement of Basel Wastes, the export and import of mercury bearing wastes has been banned under Schedule 8 of the Hazardous Waste (Management and Handling) Amendment Rules 2003. But elemental mercury and mercury containing equipment can still be freely imported.

Import policy and duty

India is importing as well as exporting several mercury as well as digital (non-mercury based) equipment.

Import of mercury

Items/Goods	Policy	Duty
Mercury	Free	56.83
Clinical thermometers	Free	50.8
Instruments for measuring blood pressure	Free	50.8[9]

Export-import of digital thermometers

Year	Export	Import
1998-99	90.19	109.08
1999-2000	65.64	50.17
2000-01	261.93	86.19
2001-02	77.22	104.97
2002-03	54.12	127.31
Apr-Sep 2003-04	267.47	40.82

Supply of mercury and mercury compounds to India (in MT/year)

Year	Export
1996-97	257
1997-98	245
1998-99	305
1999-2000	457
2000-01	522
2001-02	738
2002-03	1,385

Section 7: Rules regarding mercury usage

Indian laws and guidelines on mercury

The two rules that deal with hazardous substances are: The Hazardous Waste Management and Handling Rules (1989), which list mercury and mercury containing waste as hazardous waste. Another rule is the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989, which covers a few mercury compounds.

By the definition and categories mentioned in the Hazardous Waste Rules, mercury release from products or instruments of mercury (used in healthcare) would be covered under this rule. However, the authorities admit that mercury used in healthcare was not considered significant enough to draft any individual policy for this sector or take it into account within the existing framework.

The Indian Standard for code of safety for mercury, published by the Indian Standards Institute (ISI)

- Section 0.2.1 of this standard says that mercury and its compounds are toxic. A code of safety for mercury will be helpful in taking preventive measures for protection of health of persons exposed to this material in industry
- Section 0.5 – Mercury poisoning is included in the schedule of Notifiable diseases under the Factories Act, 1948. It is a compensable disease under the Workmen's Compensation Act, 1923
- Section 4.1.4 gives the threshold limit value in air for mercury as 0.05mg/m^3 of air for repeated exposure for 8 hours workday and 40 hours work week
- Section 5 deals with storage and handling and states that since spillage of mercury is practically unavoidable, the spilled material should be washed away to drains and collected in water sealed traps. Lime sulphur may be sprinkled over the surface to get rid of finer particles, which may be left behind
- Section 7 talks about the preventive measures- protective gear mentioned include overalls, respirator with a desired filter; emphasises on training of staff and monitoring of ventilation and working conditions, mercury vapour concentration (to be measured with electrically operated mercury vapour meters or chemical based methods)

The standard code for mercury should apply to any place, which uses mercury including the hospitals. Their implementation in the hospital setting would mean that the hospital would need to have a mercury policy and training on aspects of mercury exposure and spill management. It would also entail occupational safety through the use of protective gear; monitoring exposure limits; and ensuring water-sealed traps for mercury collection in drains.

This code needs to suggest better ways for spill handling rather than suggesting washing of mercury in drains.

Considering the order of Supreme Court on hazardous waste, the government needs to look into minimising use of toxic material and ensuring proper disposal. Currently, government policies are silent on eliminating toxic products

Why was the healthcare sector never accountable?

Waste category No.4 of Schedule in Hazardous Waste Rules covers mercury bearing waste, and the regulatory quantities are 5 kgs per year (the sum of the specified substance calculated as pure metal).

Going with a very conservative estimate (considering only mercury fever thermometers, BP apparatus and amalgams and ignoring all other uses of mercury in a hospital), an average sized hospital, with a dental wing would annually generate around 2.8 kg of elemental mercury as hazardous waste, which is disposed into drains, or yellow bags or the general waste bins indiscriminately.[10]

Bigger hospitals may fall under the regulatory quantities, but even hospitals that do not fall under this category are not absolved of their duty to manage hazardous waste as per the maintenance of health, preservation of the sanitation and environment.

Thus all generators come under the purview of the rules, though some may not need to seek authorisation.

Waste category No. 18 of the Hazardous Waste Management & Handling Rules, includes discarded containers and container liners of hazardous and toxic chemicals and wastes, irrespective of any quantity.

Hospitals buy elemental mercury to refill their BP apparatus as well as for dental use and there is no mechanism for the disposal of these containers.

Thus the hospitals have enough mercury and should be made accountable for the hazardous waste they generate.

Some other existing guidelines on mercury include the Indian Standards published by Indian Standards Institute.

Indian standard of specification for dental mercury

Section 5 on marking says that each container used to store mercury shall be marked with the words 'Poison' and 'For Dental Purposes Only.'

In the Indian standard for thermometer for mercury barometer there is no requirement of labelling the thermometer as a hazardous substance. Fever thermometers, which are present in each household and are used by the common man, who has little or no information about its content are also not labelled. Thermometers of any kind should have a mandatory marking, labelling it as a hazardous substance and should have instruction on the methods to control and manage any spill during the course of use.

There is no training imparted for safe use of mercury products to the healthcare staff. Several people get exposed to mercury without knowing of the dangers. In the Supreme Court of India, Civil original jurisdiction, Writ petition no. 657 of 1995: Order, Dated October 14, 2003 reads- "We have considered the suggestion of HPC under term of reference no. 4 relating to impact of Hazardous Waste on Worker's Health. Hav-

ing regard to the recommendations and submissions made by the learned counsel we direct the Ministry of Labour and Ministry of Industry to constitute a special committee to examine the matter and enumerate medical benefits which may be provided to the workers having regard to the occupational hazard as also keeping in view the question of health of the workers and the compensation which may have to be paid to them.

In the Supreme Court of India, Civil original jurisdiction, Writ petition no. 657 of 1995 Order, Dated October 14, 2003, reads- HPC is of the view that there are enough tasks for the MOEF to perform at the highest level, in terms of ensuring that the rest of the structure concerned with the area of environment (particularly hazardous wastes, their import, generation and disposal) functions in a manner where there is waste minimization in production, reduced used of toxics, maximum environmentally sound recycling, alternative uses of so-called wastes, reduced end of the pipe solutions and ' finally, where unavoidable, environmentally safe disposal facilities. It is the foremost responsibility of the MOEF that the, national institutional framework operates in a manner that can ensure this, and that there is a phased targetted programme of actions. It should not be satisfied with just issuing rules/guidelines that are not implemented.

Assuming all these provisions and clauses given in the Indian laws and standards, it is apparent that mercury toxicity has been acknowledged by the government bodies but adequate measures have not been adopted for safe use and disposal of this metal. Even after the availability of safer alternatives for all mercury uses in the medical sector, the government policies are silent on eliminating use of toxic products. Considering the order of the Supreme Court on hazardous waste, the government needs to look into minimising use of toxic material and ensuring proper disposal, etc.

Laws and legislations against mercury worldwide

Common features of existing national initiatives

A number of countries have implemented national initiatives and actions, including legislation, to manage and control releases and limit use and exposures of mercury within their territories.

It may take the form of laws, decrees, orders, regulations, rules, standards, norms and similar written statements of national policy and requirements for behaviour. Countries rarely have a single law to cover chemicals, including mercury, instead separate pieces of legislation and separate ministries are commonly involved, highlighting the need for cooperation between government ministries in the development, implementation and enforcement of legislation on chemicals.

Although legislation is the key component of most initiatives, safe management of mercury may also include efforts to reduce the volume of mercury used by developing and introducing safer alternatives and cleaner technology. It may also include other national measures, such as the use of subsidies to support substitution efforts and voluntary agreements with industry or users of mercury.

Such initiatives have stimulated significant reductions in mercury consumption in a number of countries, and corresponding reductions of releases have been attained.

The initiatives can generally be grouped as follows:

- Environmental quality standards, specifying maximum acceptable mercury concentrations for different media such as drinking water, surface waters, air, soil and for foodstuffs such as fish;
- Environmental source actions and regulations

Material used instead of amalgam, collection and treatment method adopted in countries[11]

Country	Methoid used	Collection and treatment method
Denmark	Plastic	Amalgam seperator prior discharge.
Estonia	Glass-ionomers, composites	Collected as waste or hazardous waste if possible, disposal
Finland	Composites, glass-ionomers	Seperators prior discharge, collection in licensed depots
Germany	Plastic, ceramic, gold-alloys	Amalgam collectors
Latvia	Light curing, filling materials	Collected by licensed company
Poland	Composites	Waste containing amalgam is collected separately
Russia	Glass-ionomers, composites	Amalgam not used
Sweden	All kinds of substitutes	Collected as hazardous waste, disposal and recovery

that control mercury releases into the environment, including limits on air and water point sources and promoting use of best available technologies and waste treatment and waste disposal restrictions;

- Product control actions and regulations for mercury-containing products, such as batteries, cosmetics, dental amalgams, lighting, paints/pigments, pesticides, pharmaceuticals, etc;
- Other standards, actions and programmes, such as regulations on exposures to mercury in the workplace, requirements for information and reporting on use and releases of mercury in industry, fish consumption advisories and consumer safety measures.

Product control regulations for mercury-containing products

Dental amalgam

A number of countries have put in place measures to reduce or even phase-out mercury in the dental sector. In addition to the use of amalgam separators to substantially reduce the amount of mercury discharges through wastewater from dental clinics (combined with appropriate service to maintain the effectiveness of these systems), some countries are also promoting the substitution of mercury-containing amalgam fillings, especially among sensitive populations including pregnant women, children and those with impaired kidney functions.

Denmark and Sweden are perhaps among those countries that have gone the farthest in attempting to eliminate the use of mercury-containing amalgam. The Swedish government's overall goal to phase-out mercury also includes dental amalgam. In Sweden the consumption of mercury for dental use has decreased significantly after a policy decision by its Parliament in 1994 to phase-out the use of dental amalgam. In the interest of protecting their citizens, Sweden, Norway, Germany, Denmark, Austria, Japan, Finland and Canada have taken steps to limit and phase out the use of amalgam restorations.

In New Zealand, a "Practice guideline - control-

ling dental amalgam waste and wastewater discharges" has been adopted, describing a code of practice on the use, storage, collection and disposal of mercury in New Zealand dental surgeries. It recommends that amalgam scrap should be collected, stored and sent for recycling or for disposal at an approved landfill when collection for recycling is not available. Amalgam scrap should be stored under water in an airtight container to reduce mercury vapour levels. Also, amalgam scrap and contaminated particulate amalgam waste should not be disposed off in any medical waste to be incinerated. Dental surgeries should use systems to reduce amalgam discharge to wastewater – in regions where reductions in total mercury discharge to wastewater are required by territorial local authorities, amalgam separators should be installed and serviced appropriately to maintain the effectiveness of these systems.

Stands on dental amalgam in select countries

- **Sweden:** In 1994, Sweden announced a phased-in ban on the use of amalgam. Presently there is a ban on the use of amalgam in anyone under the age of 19 years.
- **Denmark:** Dental amalgam is only allowed in molar teeth.
- **New Zealand:** In New Zealand, a "Practice guideline – controlling dental amalgam waste and wastewater discharges" has been adopted, describing a code of practice on the use, storage, collection and disposal of mercury in New Zealand dental surgeries.
- **Germany:** Germany has banned a certain type of amalgam (gamma 2 phase) and issued advisories against the used of amalgam in children, pregnant women and people with kidney problems.
- **Austria, Japan and Canada:** Initiated process to phase-out amalgam restorations. Restrictions or warnings on use of mercury fillings such as for children, pregnant women, women of childbearing age, people with damaged kidneys or immune systems, and in the mouth adjacent to other metals.
- **Norway:** Use of amalgam has been limited as much as possible in consideration to the environment and possible adverse health effects since July 2003.

Thermometers

Mercury-containing thermometers are a product which consumers all over the world are familiar with. In Sweden, the import, professional manufacture and sale of clinical mercury thermometers were prohibited from January 1, 1992. In addition, in order to promote collection of mercury thermometers, economic incentives have been used to persuade households to turn in their mercury thermometers. In Denmark, there is a general ban on sale of mercury containing thermometers. Exemptions from this ban are primary EU approved thermometers.

Other standards and programmes

Occupational health and safety

A number of countries have also implemented measures to ensure occupational safety and health of workers and regulate exposures to mercury in the workplace, often by establishing so-called Permissible Exposure Limits (PELs).

Information and reporting requirements

Several countries have developed systems to collect and disseminate data on environmental releases and transfers of toxic chemicals from industrial facilities, often known as Pollutant Release and Transfer Registers (PRTRs). PRTRs have proven valuable, not only to track the environmental performance of industrial facilities and the effectiveness of government programmes and policies that apply to them, but also to stimulate

voluntary initiatives by companies to reduce their releases and transfers of toxic chemicals.

An example of such a system is the United State's Toxics Release Inventory (TRI). Starting with the 2000 reporting year, the reporting threshold for mercury and its compounds has been lowered to 5 kilograms per year (the previous threshold was 4,500 kilograms).

A third example is Australia's National Pollutant Inventory (NPI), which reports information, based on estimation techniques, on the types and amounts of certain chemicals being emitted to the environment. From 2000-2001 onwards reporting will be compulsory. Enforcement is the responsibility of the relevant Australian State or Territory.

International and regional agreements

A number of countries also participate in international and regional conventions and agreements, which might set supplementary reduction goals with regard to mercury releases.

The European Commission is currently investigating further potential regulatory actions on products containing mercury, in preparation of potential amendments to the marketing and use directive. Among others, the following mercury-containing products are reported to be under consideration: button cell batteries, industrial and control instruments, lighting and thermometers (OSPAR, 2000c). Within these considerations, it is also under discussion whether a full substitution is justified, taking into account the ongoing reduction of mercury use within the European Community.

In India the regulations and safeguards for handling mercury are virtually non-existent. Mercury pollution compromises the most basic human rights – life, clean food and water, work in safe environments, environmental health. The US EPA ranks the healthcare sector as the fourth-largest source of mercury air emission due to its contribution to the medical waste incinerator. However, in India, there are no mercury emission standards specified in the Biomedical waste Rules 1998. Besides incineration, mercury also enters the environment directly as a result of improper disposal of broken thermometers and other mercury containing instruments.

On an average India produces 10 to 12 million instruments a year including clinical and laboratory thermometers as well as blood pressure measuring instruments, consuming about 15 tonnes of mercury annually. Most of the mercury from these broken equipment either goes down the drain or is collected and put in black bags. As far as the hospitals are concerned, none of them check for mercury release, either in the incinerators or in the effluent released.

The healthcare sector has not started looking at issues of emissions from waste incinerators or the effluents discharged into sewers seriously. Some policy or guideline needs to be worked out for phased elimination of mercury use and safe use and disposal of mercury products as an interim measure.

Section 8: Recommendations

For policy-makers

- Imports of mercury to be placed on restriced list, and to be phased out as alternatives come in.
- Open sale of mercury to be banned.
- Promote manufacture of digital thermometers and blood pressure instruments, non-mercury dental amalgams, through fiscal and non fiscal measures as well as awareness programs.
- Manufactures of mercury devices to be asked to take back used/collected mercury.
- Strict norms to be made for the collection and containment of mercury in health care institutions..To ensure that mercury wastes are not disposed off randomly.
- Ban incineration of medical waste to ensure no merury emissions.
- Promoting curricula development with special emphasis on hazardous substance and pollution prevention. The curricula of medical, nursing, dental, para medical, schools etc should be considered for adding this information on. Training programmes for waste management and occupational safety should include details on mercury toxicity and handling.
- Establishing a clearing-house for information relevant to mercury, for example, information on risk management strategies, appropriate alternatives and related costs, and ensuring easy access to this information.
- Given the human health concern, it is important that awareness programmes are launched to educate the populations to the risk and impact of mercury exposure in humans especially potentially vulnerable population viz pregnant women, breast feeding women, the fetus new born and young childern residing in the hot spot area's of the country and also consequences of MeHg exposure through fish consumption. There is a strong cultural pattern of fish consumption among coastal people.

For institutions/hospitals

- Phasing-out mercury containing instruments or chemicals with the safer alternatives;
- Mercury inventorisation in the hospital to assess the mercury usage and plan a phase out strategy;
- Clear policy on mercury usage and handling procedures, safeguards, spill clean up, etc ;
- Introduce reporting formats to report and register any mercury spills/ leaks;
- Complete safety precautions against any possible mercury disasters.
- Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of mercury to all health care workers;
- It is essential to handle mercury and mercury containing devices carefully. Small droplets of spilled mercury may lodge in cracks and sinks, mix with dust, accumulate on work- benches, and adhere to clothing, shoes, and jewellery;
- Thermometer container should be of plastic, glass bottles cause breakage;
- Calibration of mercury instruments should be done by trained personnel following standard procedures in a controlled environment;
- Establish mercury waste management in hospitals to ensure that no mercury enters the sewage system/incinerator/municipal bins. All the waste should be contained and dealt with as hazardous waste.

For dentists

- Separators in dental clinics to be made mandatory
- Mercury fillings to be discouraged in young children, pregnanat women and nursing mothers.
- Tie up with a hazardous waste facility to dispose off amalgam waste/ Bio medical waste facilites can collect it from dentists and redirect it to the suitable disposal site.
- Make sure that your staff and assisstants are educated about the hazards of mercury andre trained in mercury usage.
- Switch to non-mercury fillings such as composite fillings as they are safer -for you and your patients
- Test yourself and your staff regularly for mercury levels

For individuals/occupational safety

- Avoid skin contact with Mercury. Wear protective gloves and clothing. On skin contact with mercury, immediately wash or shower to remove the chemical;
- Remove all jewellery while dealing with mercury as it binds with gold and silver to form amalgams;
- Never try to reverse the process of amalgamation yourself (don't try heating/using chemicals on amalgamated surfaces);
- Wear chemical goggles and face shield;
- A person whose clothing has been contaminated by mercury should change into clean clothing promptly;
- Do not take contaminated clothes home. Family members could get exposed;
- Do not eat, smoke, or drink where mercury is handled, processed, or stored, since the chemical can be swallowed. Wash hands carefully before eating or smoking.

Mercury reference websites

- http://www.epa.gov/seahome/mercury/src/outmerc.htm
- http://www.healthbenchmarks.org/Mercury/
- http://www.noharm.org/mercury/issue
- http://www.sustainablehospitals.org/HTMLSrc/IP_factsheet_contents.html - mercury
- http://www.h2e-online.org/tools/mercury.htm
- http://www.mercurypoisoned.com/
- http://www.toxicteeth.net/about_Us.cfm
- www.informinc.org
- http://www.nih.gov/od/ors/ds/nomercury/
- www.ewg.org
- http://www.findarticles.com/cf_dls/m0ISW/2001_May/73959332/p1/article.jhtml?term=
- http://www.mercurypoisoningfyi.com/
- http://www.testfoundation.org/
- http://www.chem.unep.ch/mercury/default.htm
- http://europa.eu.int/comm/environment/chemicals/mercury/
- http://www.toxicteeth.com

References

1. www.earthlink.net/berniew1/fetaln.html

2. www.middlecities.org/PDF/mercury_bulletin.pdf

3. www.amalgam.org

4. Cation-ion with positive charge

5. Van der Waals forces: The physical forces of attraction and repulsion existing between molecules and which are responsible for the cohesion of molecular crystals and liquids.

6. Galvanic action: An electrical process by which corrosive elements are leached from one metal substance and attracted to another.

7. The Mercury in Your Mouth: The Truth About 'Silver' Dental Fillings – Quicksilver Associates

8. www.mercurysafety.co.uk/index.htm

9. Nabhi's 'New import export policy and procedures, 2002-2003'

10. Mercury waste disposed by a 300-500 bedded hospital with a dental wing

11. Helsinki Commission Land-based Pollution Group Seventh Meeting Riga, Latvia, 31.3.-2.4.2003

Other sources referenced

- UNEP Mercury Assesment Report 2002
- Dentist the Menace
- Mercury In India, Toxic Pathways
- Health Impacts of Mercury: The International Programme on Chemical Safety
- Mercury Menace: *Down to Earth* Supplement

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