

Managing Mercury - Its Safe Disposal And Waste Management A Review

Abstract

Mercury is a toxic heavy metal which is widely dispersed in nature^[1]. It has endless uses in health care sector, in dentistry as amalgam and even in common household things like compact fluorescent lamp (CFL). Complete knowledge about its safe handling and disposal is very limited. The whole environment i.e the soil, the air, the water can get contaminated if the Mercury is not handled and disposed properly. This paper discusses in detail the various measures to prevent contamination of environment with Mercury and safe and effective disposal of Mercury waste generated in health care sector, in dentistry and at house.

Key Words

Mercury, disposal, health care sector, dentistry

Introduction

When we talk of Mercury disposal the only thing that strikes in one's mind is dental amalgam. Mercury waste is generated from other sources^[2] also like broken thermometers, Sphygmomano meters, Gastrointestinal tubes, Oesophageal dilators, Bougie, Miller Abbott tubes. Various Mercury containing chemicals are used in laboratory like Zanker's solution, histological fixatives, Thimersol and Phenyl Mercury Nitrate. Mercury is also used in batteries for pace maker, ear aids & fibrillators etc. as well as in Fluorescent Lamps and Tubes, CFL, UV Germicidal lamps. Mercury is also present in thermostat of various equipments as well as in generators too.

Elemental Mercury is a heavy silvery metal that melts at -38.9°C and boils at 357°C . It is the only metal that remains liquid at room temperature. Drops of Mercury have high surface tension and appears round. The liquid droplet is very mobile and combines with other metals such as Tin, Copper, Gold, as well as Silver to form alloy.^[3]

The density of Mercury is 13.5 g/m^3 at 25°C . Mercury has highest volatility than any other metal and forms a colorless odourless gas. When Mercury is spilled, it can break into very small droplets resulting in a large total surface area. These tiny droplets can volatilize at a faster rate than room ventilation can safely dilute Mercury concentration. Vaporization rate of elemental Mercury is approximately double with every temperature increase of 10°C . Small

droplets of spilled Mercury can lodge in cracks, adhere to carpet fabric, get mixed with dust, go down in drains, stick to soles of shoes and dissolve to form alloys with metal of watches as well as of Jewellery.^[4]

Mercury Toxicity

Mercury is ubiquitous in the environment and is taken into body in one form or other via water, air, and food on daily basis. Mercury is not bio-degradable and persists in environment. When released into air, it cycles between the air, land and water and undergoes series of complex chemical physical transformations resulting in other forms of Mercury. Elemental Mercury is most common form of Mercury in the air. In aquatic system, Mercury is transformed into organic forms such as Methyl Mercury, which is more toxic than inorganic forms and accumulates in fish and other wild life as it moves up in the food chain^[5]. The Minamata bay incident in Japan is most infamous. In 1952^[6] a local plant disposed of methyl Mercury in nearby bay contaminating shell fish and causing toxic levels in local population. This kind of poisoning is called Minamata disease. Mercury vapours effects central and peripheral nervous system, lungs, kidneys, skin eyes as well as immune system and is Mutagenic.

Acute exposure to high concentration of Mercury vapors causes severe respiratory damage while Chronic exposure to lower levels is primarily associated with CNS disorder, behavioural changes and effect

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Peripheral Nervous System. It can cause eyelid tremor and vision disturbances. Symptoms of acute inhalation of high levels of Mercury vapours includes Chills, Nausea, Malaise, Chest pain, Shortening of breath, gingivitis. Symptoms of Chronic exposure to Mercury includes weakness, weight loss, gastro intestinal disturbances, and a tremor that begins with the fingers, eyelids and lips and progress to generalised trembling of the body, violent spasms of extremities and behavioural and personality changes including increased excitability, memory loss, insomnia and depression. Additionally there may be painful scaling and peeling of skin of hands and feet a condition called Acrodynia or Pinks disease.

Mercury Management at Hospitals

Predominant sources of Mercury contamination in hospitals are broken thermometers and sphygmomanometer and the people most likely to be exposed are nursing staff, patients, and cleaners.^[8] Another source of Mercury exposure is instrument repair workshop where technician carry out repair and maintenance work of defective equipment and also one of important area of concern is where to dispose defective

equipment^[9].

Prevention or control of hazardous substance is implemented in accordance with hierarchy of control^[2]. The hierarchy of control is a list of measures in priority order, that can be used to eliminate or minimize exposure to hazardous substance which is Elimination of hazardous substance and if elimination of hazardous substance is not possible then Substitution should be considered. After which other control measures like Isolation, Engineering control, Administrative controls Personal Protective Equipment (PPE) must be considered

The preferred option is substitution of Mercury based thermometers with digital or Mercury free thermometers. Mercury based sphygmomanometer could also be replaced with aneroid or digital ones. They are expensive but with many advantages like elimination of Mercury hazard, elimination of clean-up cost, elimination of staff training, elimination of disruption of normal services due to spills, elimination of high disposal costs of Mercury. Most of the big hospitals (AIIMS, RMLH, SJH, LHMC, LNJPH) in Delhi have stopped procurement of Mercury containing devices.^[10] Engineering controls are used to remove a hazard or place a barrier between worker and the hazard. Administrative controls involve safe workplace procedures, training, awareness raising and warning signs. Personal Protective Equipment (PPE) is equipment worn to protect workers from serious workplace injuries or illnesses due to exposure to chemicals.

The objective of safe management of Mercury waste is to minimize exposure to patients, health workers, waste workers and the community, and to prevent environmental pollution. The plan for safe management of Mercury^[8] includes

1. Education and training of staff and community
2. Proper maintenance of Mercury devices
3. Segregation of Mercury from infectious or regular waste. Use of appropriate container and labelling.
4. Mercury spill management-spill kit
5. Mercury waste collection plan-procedure for on site storage and transport
6. Proper disposal methods
7. External management strategies like take back arrangement with

companies for defective Mercury devices, Mercury recycling facilities.

Spill kit

Commercially available spill kit in India is manufactured by Cole Parmer India^[11]. This includes amalgamation powder, indicator powder, vapour suppressor, aspirator bottle, waste collection bottle, mixing tub with spatula, chemical sponge, one pair of nitrile gloves and one disposable bag.

A spill kit can also be made by putting together following items:^[2]

1. PPE (personal protective equipment)

- Several pairs of rubber or nitrile gloves
- Protective eye wear
- Respiratory protection-one of these-(Regular mask do not protect against Mercury vapours)

Fit tested full or half face piece air purifying respirator with Mercury vapour cartridges.

Face mask with sulphur or iodide impregnated activated carbon.

face mask with 0.3micron HEPA (high efficiency particulate air) filter to capture amalgam particles and dust.

- Apron and other protective clothing
- Disposable shoe covers

2. Containers

- Airtight sealable plastic bags (Small & large size thickness 50 to 150 microns)
- Small Air Tight rigid plastic containers with some water or vapour suppressing agent for collecting elemental Mercury
- Air Tight Puncture resistant rigid plastic or steel jar with wide opening for collecting Mercury contaminated broken glass

Each of these primary containers must be labelled and placed in a secondary containers (thick sealable plastic bag)

3. Tools For Removing Mercury

- Torch to locate shiny Mercury beads
- Thin plastic or cardboard pieces or stiff paper to push Mercury beads into a plastic scoop or pan
- Plastic scoop or Pan
- Tweezer for broken glass pieces
- Eye dropper or syringe without needle to draw up large Mercury beads
- Sticky Tape (to pick up tiny

droplet)

- Vapor Suppressor Agents like-Sulfur Powder It forms mercuric sulphide,- Zinc / Copper Flakes/ Dental Amalgam,- Commercial Absorbent Pads by Mercon-Tainer Ross Healthcare
- Utility Knife Blade

4. Material for decontamination

- Household decontaminants like Vinegar, H₂O₂
- Commercial decontaminants: Photographic Fixer, Mixture of Sodium Thiosulphate with EDTA Eg. SpilFyterDecon Solutions, Mercon wipes Ross Health care

5. Danger: Mercury waste labels to put on waste container Clean up procedure for Spill^[12]

- Quickly determine the extent of spill
- Immediately block foot traffic.
- Prevent spread of spill by blocking their path with impervious material. If anyone's skin, shoes, or clothing was splashed with Mercury, they should be removed and left around the spill area before allowing the person to leave. Contaminated skin should be washed with alkaline soap.
- Turn off central ventilation, heater or AC system.
- Open windows and exterior door to dilute vapour conc in the room.
- Remove jewellery, watches, phone and get Mercury spill kit
- Wear PPE.
- Remove hg beads and broken glasses and put them in respective containers.
- Sticky tapes to be used for tiny droplets. Place them in sealable plastic bag.
- Clean up cracks and hard surfaces by sprinkling sulphur powder a color change in powder from yellow to reddish brown indicates that hg is still present. Use the brush to collect and place them in sealable plastic bag.
- Use knife to cut contaminated soft material like carpet, bedding etc and place them in plastic sealable bag.
- Place all contaminated material used during cleanup in sealable plastic bag
- Waste container should be

labelled Hazardous Mercury Waste along with description of contents and the initial date of storage.

- Remove PPE- First shoe covers, gloves, apron, put them in sealable plastic bag. Goggles, respirator should be decontaminated.
- Wash hands and all exposed areas and ventilate the spilled area.
- Write a report on spill incident

Not to do list

- Donot use a regular vaccum cleaner.
- Donot wash Mercury contaminated clothing.
- Donot use a broom to sweep up the Mercury, it can spread them.
- Donot pour down the drain.

Mercury In Dental Office

The health risk for amalgam use is greater for office team than for a patient. Sources of Mercury vapour in dental office are Spills, Open storage of amalgam scrap, Open storage of used capsule, Trituration of amalgam, Amalgamator aerosol, Removal, placement, finishing and polishing of amalgam, Amalgam waste on cotton rolls and gloves, Heating of amalgam contaminated instruments, Mercury release from stored materials, Amalgam and Mercury in plumbing traps, Mercury trapped in tiles and carpeting and Amalgam scrap container if left open.^[13]

Management Of Mercury In Dental Office

According to hierarchy of control

1. Substitution-Now a day various other restorative materials are available which can be a substitute for amalgam. Many dental Hospitals and private practitioners are not using amalgam^[10]. But it can not be eliminated because it is the integral part of the curriculum
2. Measures to reduce Mercury vapour pressure in operatory-^{[14],[15],[16],[17],[18]}
 - a) If an accidental spill- Mercury spill kit should be available and a person should be trained in using that.
 - b) No open storage of amalgam scrap- It should be stored in tightly closed container with water, glycerine or radiographic fixer. Radiographic fixer can not be used in some countries for scrap amalgam because that itself is a Hazardous waste^[15] Amalgam scrap is of

two types- Contact amalgam which has come in contact with patient and Non contact amalgam which is excess material, has not come in contact with patient. There should be separate container for both Contact and Non contact amalgam. In Non contact amalgam container, Broken and unused capsules, Scrap amalgam (excess amalgam remaining after a procedure) should be stored. In Contact amalgam container contaminated waste like removed fillings, collected amalgam particles from filter, extracted teeth with amalgam restoration and amalgam waste on cotton rolls and gloves should be stored.

C) Operatory should be well ventilated, Air conditioning filters Should be replaced periodically. Periodically operatory should be Checked for Mercury vapour with Dosimeter and Mercury vapour Analyser. The current limit for Mercury vapour by OSHA is 50microgram/m³ in any 8hr work shift.^[19]

d) Only Pre-capsulated alloys should be used to eliminate the danger of Accidental spill and Amalgamator with completely closed arm is Advisable.

e) Amalgam should never be drained down the Plumbing lines.

f) Floor covering should be non absorbent, seamless and easy to clean.

g) High volume evacuator should be used while removing amalgam and while finishing and polishing. Evacuator system should have traps or filters. Recent recapture system include

separators^{[20],[21]} which have drastically reduced contamination of sewage system. The basic types of amalgam separation technologies are sedimentation units, centrifuge units. These units cause foaming with American vacuum system. Ion exchange units use polymer to capture small particles. ISO11143 compliant amalgam separators should be used on suction line to remove over 95% of amalgam particles^[22]

h) Amalgam contaminated gloves, cotton rolls, napkin should not be discarded with normal BMW. They should be stored separately in sealed plastic bags

Mercury Management In Cfl Sector^[23]

At Manufacturing level - In India there are no specific norms prescribed for the Mercury emissions. At consumer level- Used lamps are collected by kabari and handed over to glass recyclers, which is highly un-organised sector. Used lamps

are thrown in garbage bins and finally into municipal garbage dumpsites contaminating air, water and soil. A portion of Mercury in vapour form is released into the air, whereas rest of Mercury is released onto the soil with further possibility of getting into the surface and /or ground water bodies.

International Scenario

Most western countries follow WEEE (waste electrical and electronics equipment) directives based on the concept of extended procedures responsibility. The US has independent market oriented system, where the consumer is required to pay money and efforts both for collection, treatment and disposal at the centers recognized by the concerned regulatory authority.

In case of breakage following should be done^[4]

Before clean up

- Have pet and people leave the room
- Open windows.
- Switch off AC
- Collect material needed to clean up broken bulb

During cleanup

Be thorough in collecting and place it in sealable container. After cleanup place the container outdoor until it can be disposed off properly. For several hours continue to air out the room and leave the heating and AC system shut off.

Storage of Mercury waste^[24]

Storage of mercury waste for longer period should be avoided. Mercury waste must be sent to authorized Centralized Storage facility. Waste in Temporary storage area should be disposed of with in 90 days safely following HW (M, H & TM) Rules, 2008 notified under the Environment (protection) act, 1986, in consultation with respective State Pollution Control Board (SPCB)/ Pollution Control Committee (PCC).

Suggested Precautions for storage of Mercury Waste are

1. It should be a locked dedicated area.
2. The storage area should be marked clearly by fencing posts or walls in order to limit access to it.
3. A recording system on the condition of storage should be established.
4. The site should be subjected to routine inspections.
5. Only trained personal should be

handling containers in storage.

Mercury Waste Disposal^[24]

While disposing Mercury waste, care should be taken that the manifest, as stipulated under the Hazardous Waste (Management, Handling & Transboundary Movement) HW (M, H &TM) Rules, 2008 are followed to ensure that the Mercury waste is delivered at designated place for the intended purpose.

Environmentally Acceptable Disposal Options are

1. Disposal through medical equipment manufacturers Mercury waste should be recycled following the principles of Extended Producer Responsibility (EPR). For example defective or broken Mercury containing medical equipment.
2. Disposal through Mercury recovery units Done by Mercury distillation or roasting methods. But at present there are no Mercury recovery units in our country as in developed countries.
3. Disposal through Hazardous Waste Treatment Storage and Disposal Facility (TSDF) It is most commonly used option in India. Mercury waste is disposed of through a nearby authorized Common Hazardous Waste Treatment, Storage and Disposal Facility (TSDF) following the manifest as stipulated under HW (M, H &TM) Rules, 2008 for final disposal of such waste in a secured landfill after ensuring pre-treatment by stabilization technique meeting the requirement of criteria as suggested under CPCB (Central Pollution Control Board) guidelines. TSDF centre working in Punjab is with only secured landfill facility at Nimbua, Derabassi and in Himachal Pradesh Its at M/S Shivalik Solid Waste management Ltd. Vill Majra, P.O Dabhota, The Nalagarh, Distt Solan.
4. Disposal through a Common Biomedical Waste Treatment Facility (CBWTF) CBWTF operator collects the waste daily from the member health care facility on charge basis for further treatment and safe disposal as to be authorized by the SPCB/PCC under BMW guidelines.

Conclusion

Thorough knowledge regarding Handling

of Mercury waste as well as Mercury mishap and safe disposal of Mercury waste is need of hour. Proper Preventive measures along with strict implementation of rules and regulations of State Pollution Control Board regarding safe disposal of Mercury waste can prevent Mercury from entering the environment.

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