Demonstrating and Promoting Best Techniques & Practices for Reducing Health-Care Waste to Avoid Environmental Releases of Dioxins and Mercury

ISSUE 3 SEPTEMBER 2011

SPECIAL POINTS OF INTEREST:

- **Mercury in the atmosphere has increased 20 times since 1840 (UNDP-GEF, AUB, 2011)**
- **Lebanese healthcare sector releases around 31 kg of mercury into the environment each year.**
- **1 broken mercury thermometer can contaminate around 1% of Qaraoun lake (100k m²) (UNDP-GEF, AUB, 2011)**

INSIDE THIS ISSUE:

Mercury

Mercury (Hg) is a heavy, mobile, silvery metal that exists as a liquid at room temperature. It is highly volatile and forms a colorless, odorless gas. Mercury can exist in two other chemical forms, inorganic mercury compounds (such as mercuric chloride, and mercuric sulfide), and organic mercury compounds (such as methyl mercury, thimerosal, etc.)(Emmanuel, 2010) .

When mercury is spilled, it can break into tiny droplets over a large surface area. These droplets can volatilize at a rate so fast that normal room ventilation may not be sufficient to safely dilute the mercury vapor concentration. Small droplets of spilled mercury can lodge in cracks, adhere to carpet fabric, mix with dust, go down drains, stick to the soles of shoes, and dissolve to form alloys with the metals in watches and jewelry.

Mercury vapors from the carpet seen under UV light (Emmanuel & Orris, 2010)

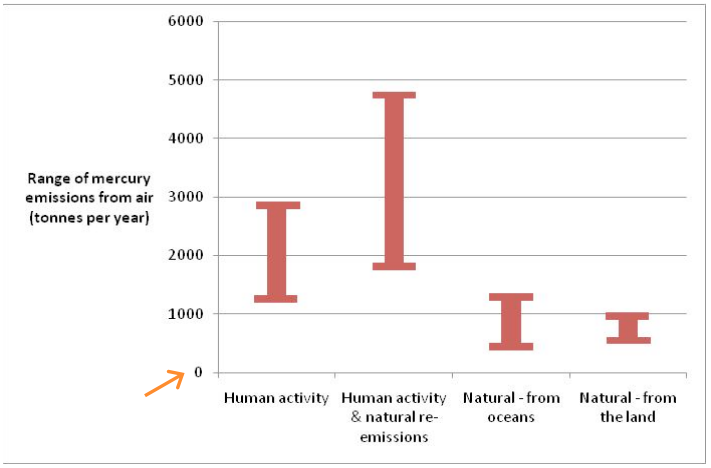


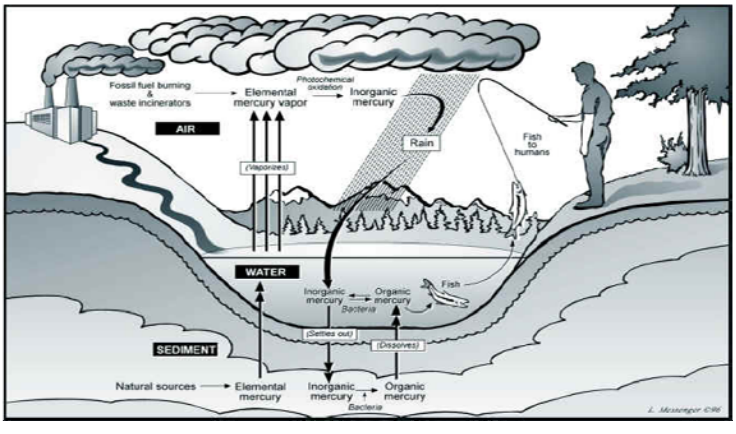
Chart showing the estimated range of global atmospheric mercury emissions in one year. (Emmanuel & Orris, 2010)

Some materials are resistant to mercury.

Human activities account for about 70% of the mercury emissions compared to natural resources. The health care industry contributes to the release of mercury into the environment through the breakage of mercury-containing devices, spills, improper disposal and the incineration of medical wastes.

Mercury is non-biodegradable and persists in the environment cycling between the air, water and land. In aquatic systems, mercury is transformed into organic forms such as methyl mercury which is more toxic than inorganic forms, and it bioaccumulates in fish and other wildlife as it moves up the food chain eventually reaching humans.

The Mercury Cycle (Utah Department of Environmental Quality, 2011)



"Even a small quantity of mercury can lead to mercury poisoning, particularly in children" - HCWH

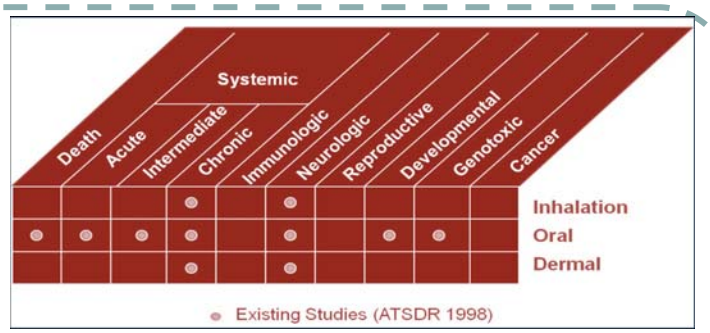
Health Impacts of Mercury Exposure

All forms of mercury are toxic at varying degrees, but the health effects depend on:

1. The form of mercury (elemental, organic or inorganic);
2. The type of exposure (acute, or chronic);
3. The route of exposure (inhalation, ingestion or dermal);
4. The amount of mercury.

Inhalation of mercury vapor leads to damage in the central and peripheral nervous systems, lungs, kidneys, skin and eyes. It also affects the immune system and is mutagenic.

A study investigating the impact of prenatal methyl mercury exposure on cognitive development showed that exposure sufficient to increase the mercury concentration in maternal hair at child birth by 1 micrograms per gram could decrease the child's IQ by about 0.7 points (Emmanuel & Orris, 2010). Dentists and dental assistants are exposed to metallic mercury vapor from dental amalgam; thus they are highly susceptible to mercury poisoning due to the long-term accumulation of low levels of mercury. Data retrieved from dental clinics in Beirut, Lebanon showed that among 99 dentists tested, 25.25% had a hair mercury level above the safe baseline of 5µg/g (Harakeh, Sabra, Kassak, & Doughan, 2002) .



Health impacts of methyl mercury exposure on humans (Emmanuel & Orris, 2010)

Environmental Costs of Mercury

Mercury pollution has a variety of costs, so-called externalities, not included in the prices the producers and consumers pay for products and services:

- Reduced recreational value of polluted areas;
- Culture losses;
- Reduced biodiversity, fish and other feed and food resources not suitable for consumption or become extinct;
- Health effects from Hg entering the body via contaminated food, soil, water and air. (Hylander & Goodsite, 2006)

One study investigated the environmental costs of mercury pollution in the Arctic. It showed that with an average annual marine production value of 128.7 million US$, Greenland alone runs an estimated 31.5 million US$ in costs of Hg polluted marine products (up 24.5% of the total production value is lost due to mercury pollution).

The study also showed that in Greenland, the cost of lost IQ due to methyl mercury toxicity of children born is estimated to 59.1 million US$ each year (considering that loss of intelligence causes diminished economic productivity over the entire lifetime) (Hylander & Goodsite, 2006).

(Brinkerhoff, 2010)

Mercury-Containing Devices in Healthcare Facilities

Mercury can be found in a number of products and devices used in healthcare facilities, some of which are listed below (Health Care Without Harm, 2010).

- Thermometers;
- Sphygmomanometers;
- Dental Amalgam;
- Batteries;
- Ultraviolet thermostats
- Thermostat probes in electrical equipment;
- Pressure gauges;
- Chemical and pharmaceutical products that may contain traces of mercury as a contaminant or additive;
- Cleaners and degreasers with caustic soda or chlorine contaminated with mercury.

Refer to the table on the next page for examples of mercury -containing chemicals.

Dental Amalgam Capsule (FDA, 2009)

Mercury Waste Management for Dental Facilities

Mercury is about 50% of dental amalgam by weight. In many dental facilities, a powder mix of metals (generally silver, tin, copper, and zinc) are weighed and mixed with mercury to form the amalgam. Depending on the size of the amalgam, the amount of mercury could range from 327 to 982 milligrams per amalgam.

Dental facilities are a significant source of mercury in the wastewater.

The amount of mercury discharged by a single dental facility depends, among others, on whether or not mercury retention devices are used. When no filters are used, one study estimated an average of 2 grams of mercury per dentist per day may be discharged into the wastewater.

The first recommendation in mercury waste management for dental facilities is to use amalgam substitutes in cases where they are appropriate and feasible. Some commercially available alternatives to mercury are: cold silver, gallium, ceramic, porcelain, polymers, composites, and glass ionomers. However, these alternatives are not yet widely known nor accepted in many countries.

General recommendations regarding mercury retention devices for dental facilities:

- Have multiple levels of amalgam retention devices installed as much as possible, since chair-side traps and vacuum pump filters only remove between 40 to 80% of amalgam from the wastewater. Multiple levels refer to the installation of dental amalgam separators and vacuum filters along with chair-side traps.

Figure 1 gives examples of different configurations of multiple amalgam retention devices depending on whether a dry or wet vacuum system is used.

- After installing amalgam retention devices, replace old plumbing sink traps and other low points in the plumbing where amalgam may have settled. Collect, store, and label the amalgam waste (Emmanuel, 2011).

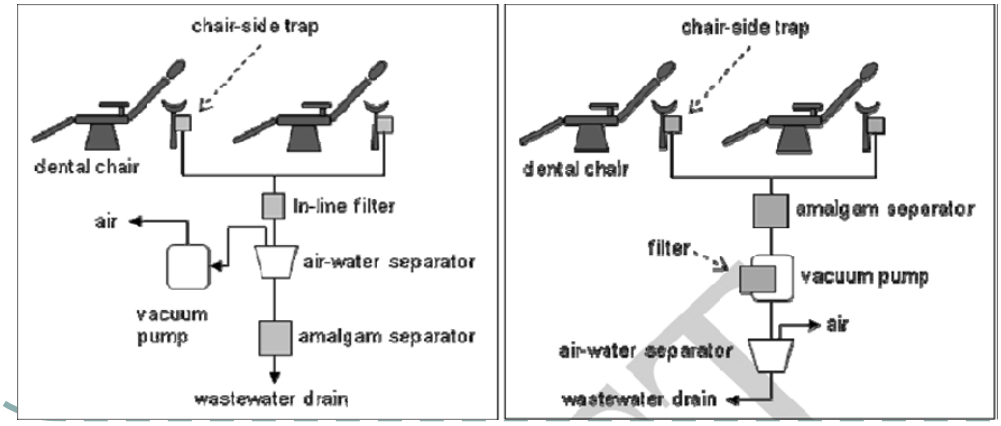


Figure 1: Examples of Multiple Levels of Amalgam Retention Devices (Emmanuel, 2011)

Alternatives to Mercury-Containing Devices in healthcare Facilities

Mercury-free sphygmomanometers: aneroid (left), digital oscillometric (right) (UNDP-GEF, 2010)

Mercury-free thermometers: electronic (left), compact electronic (right) (UNDP-GEF, 2010)

Mercury-containing Device	Alternatives
Thermometers	Mainly digital or electronic thermometer
Sphygmomanometer	Aneroid or oscillometric devices
Amalgam dental fillings	Glass ionomer/composite/resin fillings
Thermostats	Electronic
Fluorescent tubes	Bulbs with low Hg content
Batteries	Mercury-free/ rechargeable batteries (lithium, zinc, alkaline)
Manometers	Electronic
Gastrointestinal tubes	Tubes with tungsten weights
Chemicals	**Alternatives**
Mercury (II) chloride Zenker's solution Histological fixatives	 Zinc formalin Freeze drying
Staining solutions and preservatives for such products as buffers and vaccines: Thimerosal, Immu-sal, Carbol-fuchin stain, Gram iodine stain, phenolic mercuric, actate, alum, Hematoxylin "Solution A"	Replace with variety of chemical compounds
Mercury (II) oxide	Copper catalyst
Mercury chloride	None identified
Mercury (II) chloride	Magnesium chloride/sulfuric acid or zinc formalin, freeze drying
Mercury (II) sulfate	Silver nitrate/potassium/ chromium- (III) sulfate
Mercury iodide	Phenate method
Mercury nitrate (for corrosion of copper alloys) for antifungal use (mercurochrome)	Ammonia/copper sulfate Neosporin mycin

For more details see:

Emmanuel, J. (2010). Guidance on the Technical Specifications of Non-Mercury Devices. UNDP-GEF.
Health Care Without Harm. (2010). Guide for Eliminating Mercury from Healthcare Establishments.

Case Study: Comparative Evaluation of Non-Mercury Thermometers in Nabatieh Governmental Hospital and Healthcare Staff Preferences

A study evaluating available, affordable and accurate alternatives to mercury containing thermometers was conducted using the Nabatieh Governmental Hospital (NGH) as the pilot facility for the phasing out plan (of mercury-containing devices). The study examined the differences between two non-mercury alternative thermometers and the nursing staff preferences based on the following primary attributes: costs, maintenance, lifespan, accuracy and ease of use.

Economic comparison of the different alternatives showed the cost effectiveness of the electronic thermometer, especially on the long run. Based on this comparative evaluation of thermometers, compact electronic and electronic thermometers appear to be the most cost effective types.

Nursing leadership favored the electronic and the compact electronic thermometers. Clinical evaluation of the two alternative thermometers showed that their readings differed significantly, both statistically and clinically. Since the electronic thermometer is the more established alternative as per the literature, the compact electronic thermometer was not found to be an accurate replacement for it.

Clinical evaluation of the ease of use reflected a significant difference in the measurement time, again favoring the electronic thermometer. The nursing staff expressed preference for the electronic thermometer regarding its user friendliness, patient acceptability, and infection control, while compact electronic thermometer was favored for durability.

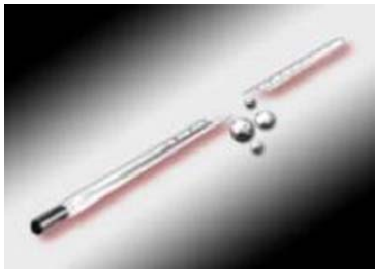
In conclusion, the study provided evidence for the superiority of the electronic thermometer, of the brand available in the Lebanese market, as the best alternative for the mercury thermometer.

For the details of the study, refer to: Nafaa, A. I. (2011). *Comparative Evaluation of Non-Mercury Thermometers in Nabatieh Governmental Hospital and Healthcare Staff Preferences.* UNDP -GEF Global Healthcare Waste Project.

Comparative Costing of Thermometers in USD ($) (Nafaa, 2011)

Type of Thermometers	Electronic	Compact electronic	Infrared tympanic	Infrared temporal	Mercury
Total investment cost	10,029	2,719	3,292	6,580	23,092
Total annual running cost	8,807	15,603	30,543	33,556	31,213
Total cost at year one	18,836	18,322	33,835	40,136	54,305

Managing Small Mercury Spills



(Emmanuel & Orris, 2010)

NEVER:

⊗ use a vacuum cleaner to clean up mercury
⊗ use a broom to clean up mercury
⊗ pour mercury down the drain
⊗ wash mercury-contaminated items in a washing machine
⊗ continue wearing shoes and clothing that might have been contaminated in the mercury spill
⊗ burn anything that has been contaminated with mercury

Spill Kit

Although mercury spill kits are commercially available, a spill kit can be made by putting together the following items and storing them in a marked box or portable container.

◊ Step-by-step instructions with waste collection and disposal protocols;

◊ Personal protective equipment (PPE):

- Rubber or nitrile gloves;
- Safety goggles or protective eyewear;
- Respiratory protection (face mask);
- Coveralls, apron, and other protective clothing (e.g. disposable shoe covers);

◊ Containers:

- Air-tight, sealable plastic bags (small and large sizes, thickness: 2 to 6 mils, or 50 to 150 microns);
- Air-tight, rigid plastic container with vapor suppression agent for collecting elemental mercury ;
- Air-tight, puncture-resistant, rigid plastic or steel container with a wide opening for collecting mercury-contaminated broken glass;
- Plastic tray;
- Regular plastic waste bags (thickness: 2 to 6 mils, or 50 to 150 microns);

◊ Tools for removing mercury

- Flashlight;
- Cardboard strips or thin pieces of plastic;
- Small plastic scoop or plastic dust pan ;
- Tweezers;
- Eyedropper or syringe (without the needle);
- Duct tape or sticky tape;
- Vapor suppression agents:
  ⇒Sulfur powder (available from pharmacies), zinc or copper flakes (available from hardware stores);
  ⇒Brush to remove powder or flakes;
- Utility knife blade;

◊ Materials for decontamination:

- Vinegar, hydrogen peroxide, and cotton swabs for final cleaning when using sulfur powder;
- Decontaminant solution or commercial decontaminant;
- Piece of soap and paper towels;

◊ "Danger: Mercury Waste" labels to put on waste containers.

All spill kits should have a sheet attached indicating when they were used and verifying that the expended supplies have been replaced. The sheet should be signed and dated by the responsible staff (Emmanuel, 2010).

(Health Care Without Harm, 2010)

This detailed mercury spill cleanup procedure is intended as a guide to help develop facility-specific procedures. Each healthcare facility should develop its own procedures according to what is practical and available while maximizing protection for their patients and health workers. (Emmanuel, Guidance on Cleanup... , 2010)

Mercury Spill Cleanup Procedure

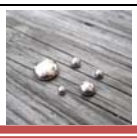
Put on personal protective equipment (rubber or nitrile gloves, apron, goggles and facemask)

Evacuate the spill area and turn off ventilation system. Ensure good ventilation by opening windows and doors to outside areas free of people.

Block the path of the mercury beads with rags or impervious material.

Identify the surface contaminated:

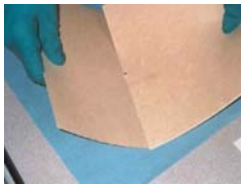
- hard surfaces can be easily cleaned.
- carpet, curtains, upholstery and the likes cannot; these should be cut off and thrown away.



Wash skin that came in contact with mercury using alkaline soap.

Remove broken glass pieces using tweezers. Place them in puncture-resistant container over the tray.

Locate all the mercury beads.



Using cardboard strips slide the mercury beads onto the plastic dustpan or scoop, and away from any carpet or porous surface. Use an eyedropper or syringe for small beads.

Carefully place the mercury beads into the plastic container partially filled with water or vapor suppression agent. Do this over the tray to catch any spillage.

Use sticky tape to pick up tiny droplets of mercury. Place in a sealable plastic bag.

Shine flashlight at low angles on floor and locate shiny mercury beads.

Place ALL contaminated materials into a leak-proof sealable plastic bag.

Clean thoroughly with decontaminant solution items that can be reused (tweezers, tray...etc.)

Ensure that all mercury-contaminated waste is now secured in labeled bags and will be disposed properly. The mercury waste can be stored temporarily on-site.

Document the incident according to procedures of the health facility. The report can be used to improve safety in the facility.

"Knowing is not enough; we must apply. Willing is not enough; we must do."
—Goethe

Elements for Temporary On-site Storage

STORAGE AREA:

Siting

- Secure restricted area.
- Readily accessible to authorized staff.
- Separate from regular infectious waste storage area.

Design

- Enclosed area (roof and walls).
- Locked door.
- Proper size (based on amount of waste and devices to be stored).
- Ventilation— exhaust vent directly to outside, away from intake vents with ventilation control.
- Seamless, smooth and impervious floor (polyurethane coated, epoxy-coated cement, or seamless rubber).
- Bunding or waste containment tray on the floor below the waste containers (125% volume of mercury stored).
- Storage are kept dry and cool (25ºC and < 40% humidity).
- Spill kit, PPE and wash station available near (but not in) the storage area.

Signage

- Entry and exit doors marked with warning signs: "Danger: Hazardous Waste" and the skull-and-crossbones symbol.
- Containers labeled "Hazardous Mercury Waste" with a description of contents and initial date of storage.

GENERAL STORAGE APPROACH

- Use primary containers for storage of mercury waste: leak-proof, airtight, non-brittle, and made of material that does not amalgamate with mercury (for sharps and mercury devices, use puncture-resistant containers).
- Add vapor suppression agent for elemental mercury and dental amalgam waste.
- Use secondary containers as a redundant safety measure.
- Label containers with date of initial storage, content type and quantity of waste.
- Place spill-control trays under the storage containers (Emmanuel, 2010).

(Emmanuel, 2010)

Labeling on primary storage container (Abejar-Arago, 2008)

Sealed and labeled secondary container ready for storage. (Abejar-Arago, 2008)

Mercury waste storage containers with spill containment trays placed below (UNDP-GEF)

For more details on mercury waste management refer to:
Emmanuel, J. (2010). *Guidance on Cleanup, Temporary or Intermediate Storage, and Transport of Mercury Waste from Healthcare Facilities.* UNDP-GEF.

Some Guidelines for Mercury Waste

Packaging:

- In preparation for transport, mercury waste should be placed in a transport container that is closed, structurally sound, compatible with the contents, and designed to prevent release of mercury. If the original transport case or box in which devices were shipped is still in good condition, it can be used for shipment of unbroken devices.
- The mercury waste should be packed carefully with packing material such as plastic bubble wrap or plastic packing foam to prevent breakage inside the container.
- The transport container should be tightly sealed to prevent escape of mercury if breakage occurs.

Labeling:

- The outside of the container used for transport should have a clear label "Hazardous Mercury Waste."
- The label should also include content (chemical composition or description of the waste), warnings, special handling procedures if necessary, emergency contact numbers, and the name and contact information of the generator.

Preparation:

A special permit/license for transporter is given by the regulatory authority.

Registered vehicle

- Passed inspection
- Closed design, correct size for the intended load
- Bulkhead between driver cabin and body
- System to keep load secure during transport
- Spill kit, first-aid kit, fire extinguisher
- Placard

Off-site Transport

- Before transport, the transporter should inspect all the waste containers to ensure that they are packed and labeled properly.
- The waste containers should be placed in the back of the vehicle (not in the passenger section).
- All waste containers should be firmly secured such that the containers do not tip over, slide, or shift during accelerations, stops, turns, and driving over bumps and holes on the road.
- Containers should not be stacked more than 1.5 meters high.
- The transport vehicle should be kept locked whenever there is waste in the vehicle except during inspection, loading, and unloading.
- The transporter should transport the waste as soon as possible using the safest or most direct route to the storage facility.
- The transport vehicle should be kept clean and maintained in good running condition.
- The registered vehicle should be used to transport mercury and other hazardous wastes only (Emmanuel, 2010).

For more details on mercury waste transport refer to:

Emmanuel, J. (2010). *Guidance on Cleanup, Temporary or Intermediate Storage, and Transport of Mercury Waste from Healthcare Facilities.* UNDP-GEF.

General Procedures

- All personnel involved in collection, storage, transport, and supervision of mercury waste should receive special training on mercury waste management including spill cleanup.
- Material Safety Data Sheets and International Chemical Safety Cards on mercury should be discussed with employees.
- The most senior staff involved in a cleanup is responsible for ensuring replenishment of the contents of the spill kits.
- The storage space should be inspected every month to check for leaks, corroded or broken containers, improper methods of storage, ventilation, the condition of the PPE and wash area, spill kit contents, and updated records.
- Inventory records should be kept of the types of mercury waste, descriptions, quantities in storage, and initial dates of storage.
- No smoking or eating should be allowed in and around the storage space (Emmanuel, 2010).

Demonstrating Best Techniques and Practices for Reducing Health Care Waste to Avoid Environmental Releases of Dioxins and Furans

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"Special acknowledgment to Ms. Diana Mikati for preparing this issue during her internship at the project".

Project Objectives

The overall goal of this project is to protect public health and the global environment from the impacts of dioxin and mercury releases. To achieve this, the project is demonstrating best environmental practices and best available technologies at healthcare facilities that have been selected to serve as models. The project focuses primarily on activities such as promoting the use of non-burn waste treatment technologies, improved waste segregation practices and the use of appropriate alternatives to mercury-containing devices. These activities are reflected in the following seven project objectives:

- Establish model facilities and programs to exemplify best practices in healthcare waste management.
- Deploy and evaluate commercially available, non-incineration healthcare waste treatment technologies appropriate to the needs of each country.
- Introduce and evaluate the use of mercury-free devices in model facilities.
- Establish or enhance training programs to build capacity for the implementation of best practices and technologies both within and beyond the model facilities and programs.
- Review and update relevant policies.
- Disseminate project results and materials to stakeholders and hold conferences or workshops to encourage replication.
- Make project results on demonstrated best techniques and practices available for dissemination and scaling-up regionally and globally.

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