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GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

GLOBAL HEALTHCARE WASTE PROJECT

MODULE 20:
Management and Storage of Mercury Waste

World Health Organization

Health Care Without Harm

UIC SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF ILLINOIS AT CHICAGO
Environmental and Occupational Health Sciences Division

Module Overview

- Present data on toxicity and occupational limits for mercury
- Explain the hierarchy of mercury waste management
- Describe elements of a mercury phase-out
- Describe materials needed and procedures used to clean up a mercury spill
- Present the requirements for interim on-site storage of mercury waste

Learning Objectives

- Understand the toxic properties of mercury
- Know the hierarchy of mercury management
- Know how to develop a phase-out plan
- Adapt the material and procedural requirements for cleaning up a mercury spill to one's own facility
- Develop a storage site that meets basic requirements

Global Mercury Trends

- The concentration of mercury in the atmosphere has increased by a factor of 20 since 1840
- Human activities account for about 70% of the mercury compared to natural sources

WHO Policy Paper on Mercury (August 2005)

- Short-term: **Develop mercury clean-up, waste handling and storage procedures**
- Medium-term: **Discourage mercury use in health-care settings**
- Long-term: **Ban use of mercury-containing devices and promote use of mercury-free alternatives**

Toxic Properties of Mercury

- Toxicity based on exposure

- Acute exposure: tremors, slowed motor nerve functions, memory loss
- Acute inhalation: chest pains, acute renal failure, shortness of breath
- Acute ingestion: nausea, vomiting, abdominal pains
- Chronic exposure: tremors, erethism (abnormal irritability), gingivitis, kidney damage
- Prenatal exposure: developmental disorders, Minamata disease at high concentrations

Toxic Properties of Mercury

- Occupational exposure limit:

  0.02 mg of Hg vapor per m^3 in air

  - Air saturated with mercury at 25°C is 1000 times higher than the occupational exposure limit

Mercury vapors from a spill are invisible but can be seen under UV light and a fluorescent screen

Bowling Green State University: http://wbgustream.bgsu.edu/bgsu/epa/index-fl.html

Hierarchy of Controls in Mercury Waste Management

- Elimination and Substitution
  - Develop and implement a mercury phase-out plan
- Engineering controls
  - Construct safe mercury storage facilities
- Administrative controls
  - Evaluate causes of spills and adopt preventive measures
  - Conduct awareness-raising and trainings
  - Promote safe handling procedures
  - Use educational posters and warning labels
  - Provide mercury spill clean-up kits
- Personal protective equipment
  - Use proper PPE during spill clean-up

Inspection and Maintenance of Mercury Sphygmomanometers

- Mercury sphygmomanometers should be calibrated at least every 12 months or more frequently if the zero reading is off
- Check that the mercury liquid is clean; black discoloration due to mercuric oxide may require cleaning of the column and reservoir
- Check the angle of the column
- Check that the reading is at zero mark when no pressure is applied
- Test the cuff and tubing for air leaks or blockage; test the column and reservoir for mercury leaks, especially through seals and discs
- Check that during cuff inflation the mercury rise is smooth
- Check that when inflation is stopped mercury rise stops immediately
- Clean and disinfect the device every 6 months according to the manufacturer's specifications

Elements of a Mercury Phase-Out Plan

- Conduct an inventory of mercury-containing materials in the facility, including data gathering on the rates of breakage of mercury thermometers and sphygmomanometers
- Adopt a policy to phase-out mercury; join the global campaign for mercury-free health care
- Conduct awareness-raising sessions for the staff on the hazards of mercury and the rationale for mercury-free health care

Elements of a Mercury Phase-Out Plan

- Work with procurement and professional staff to identify mercury-free devices and materials that comply with national or international standards and meet the needs of the facility
- Conduct trials if necessary to select products that meet standards and facility needs
- Work with vendors and suppliers to obtain volume discounts and to see if vendors can assume responsibility for taking back and managing old mercury devices

Elements of a Mercury Phase-Out Plan

- Develop a budget for a rapid or gradual (phased) replacement of mercury-containing materials
- Develop the infrastructure for maintenance, validation and/or calibration of non-mercury devices
- Develop a safe, interim storage site for mercury devices and waste
- Discontinue programs that provide mercury thermometers to patients or new mothers

Elements of a Mercury Phase-Out Plan

- Procure mercury-free materials
- Train staff on the new procedures or protocols related to non-mercury devices and materials
- Conduct a mercury exchange (replace each mercury device with a non-mercury device) based on a rapid or phased replacement plan
  - For example, mercury exchanges can be done for the whole facility on a set date; or on separate target dates for each department; or replace whenever mercury devices are due for maintenance or calibration; or when non-mercury devices become available based on priority areas

Elements of a Mercury Phase-Out Plan

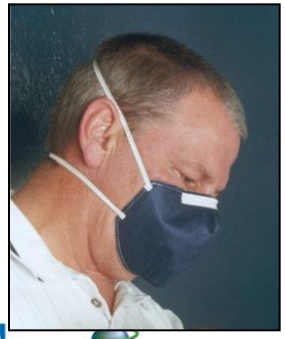
- Publicize the health facility's mercury-free status in the media to educate the community and encourage other health facilities
- Work with local and national authorities on mercury thermometer collection programs and on long-term storage of mercury waste
- Work with local and national authorities on national policies to reduce mercury pollution
- Promote compliance with the international mercury treaty and other global initiatives

Managing a Mercury Spill

- Personal protective equipment (PPE) needed to clean a spill:
  - A pair of rubber or nitrile gloves
  - Safety goggles or protective eyewear
  - Coveralls, apron, and other protective clothing
  - Disposable shoe covers
  - Respiratory protection (see next slide)

Managing a Mercury Spill

- PPE needed for a spill (cont'd): Respiratory protection



» Fit-tested full-face or half-face piece air-purifying respirator with mercury vapor cartridges, *or*

» Face mask with sulfur or iodide impregnated activated carbon (Note: Face masks that do not seal tightly around the face could allow contaminated air to enter through the edges), *or*

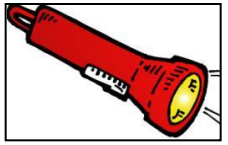
» Specialty mask or respirator designed for mercury, *or*

» Two tight-fitting face masks with activated charcoal-impregnated cloth or activated carbon in between.

» *If none of the above are available*: a face mask with a 0.3 micron HEPA filter to capture amalgam particles and mercury-laden dust (unfortunately, regular masks will NOT protect against mercury vapor)

Managing a Mercury Spill

- Other things needed to clean a spill:
  - Flashlight
  - Plastic-coated playing cards or thin pieces of plastic
  - Small plastic scoop or plastic dust pan
  - Tweezers
  - Eyedropper or syringe (without the needle)
  - Duct tape or sticky tape
  - “Danger: Mercury Waste” labels to put on waste containers



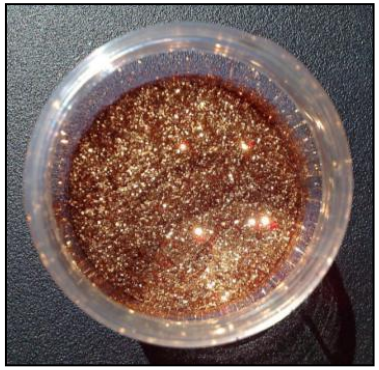
Managing a Mercury Spill

- Other things needed to clean a spill: Containers for mercury waste
  - Air-tight, sealable plastic bags (small and large sizes, thickness: 2 to 6 mils, or 50 to 150 microns)
  - Small, air-tight, rigid plastic container with some water or vapor suppression agent
  - Air-tight, puncture-resistant, rigid plastic or steel jar or container with a wide opening
  - Regular plastic waste bags (thickness: 2 to 6 mils, or 50 to 150 microns)
  - Plastic tray

Managing a Mercury Spill

Other things needed to clean a spill: Vapor suppression agents

- Sulfur powder (may be available from pharmacies) *or*
- Zinc or copper flakes (may be available from hardware stores) *or*
- Commercial absorbent pads or vapor suppressants, and
- Brush to remove powder or flakes



Managing a Mercury Spill

Other things needed to clean a spill:

- Materials for decontamination
  - Decontamination solutions can be made of sodium thiosulfate solution (photographic fixer), *or*
  - A mixture of sodium thiosulfate and EDTA, *or*
  - Vinegar, hydrogen peroxide, and cotton swabs for final cleaning when using sulfur powder, *or*
  - Commercial decontaminant kit, and
  - Piece of soap and paper towels

Managing a Mercury Spill

- Procedure to clean up a mercury spill

1. Quickly determine the extent of the spill
2. Immediately block off foot traffic for a radius of about 2 meters around the spill
3. Contain the spill – use rags or impervious materials to prevent mercury balls from spreading or falling into cracks or drains
4. Evacuate the immediate area – give priority to pregnant women and children
5. Minimize the spread of vapors to interior areas – close doors to interior areas, turn off ventilation or air conditioning that circulates air to other areas

Managing a Mercury Spill

- Procedure to clean up a mercury spill

6. Reduce vapor concentrations in the spill area if possible – open doors or windows that lead to outside areas that are free of people

7. Prepare for clean-up by getting the mercury spill kit and removing your jewelry, watch, mobile phone and other metallic items that could amalgamate with mercury; cover eyeglass metal frames

8. Put on PPE – put on old clothes, apron or coveralls, shoe covers, rubber or nitrile gloves, eye protection and respiratory protection

Managing a Mercury Spill

- Procedure to clean up a mercury spill

9. First remove visible mercury balls and broken glass beginning from the outer edge of the spill and moving towards the center of the spill

    - Place the wide mouth jar on the plastic tray
    - Use tweezers to remove broken glass
    - Use playing cards or pieces of plastic to slide mercury balls into the scoop then into the jar over the tray to catch spillage
    - Use the eye dropper or syringe to capture small mercury beads

Managing a Mercury Spill

- Procedure to clean up a mercury spill

10. Search and remove tiny mercury droplets
    - Shine the flashlight at low angles to see reflections of tiny droplets; use sticky tape to pick up tiny droplets and place the tape with the mercury in a sealable plastic bag
11. Clean up cracks and hard surfaces
    - Sprinkle sulfur powder, zinc or copper flakes on cracks, floor crevices and hard surfaces that have come in contact with mercury; use a brush to collect the powder or flakes and put them in a resealable bag
    - Wipe with vinegar-soaked and peroxide-soaked swabs

Managing a Mercury Spill

- Procedure to clean up a mercury spill

12. Remove contaminated soft material – use a knife to cut out contaminated carpets, rugs, etc. and put in a resealable bag

13. Clean out contaminated drains – carefully transfer any mercury in the J or S trap and transfer to an air-tight container; replace the trap

14. Dispose of decontaminated material in leak-proof, sealable plastic bags and dispose as mercury waste

15. Label and seal all contaminated material

Managing a Mercury Spill

- Procedure to clean up a mercury spill or decontaminate PPE

16. Wash hands and all exposed skin with soap and water

17. Ventilate the spill area

    - Place heaters and fans to volatilize residual mercury and to blow contaminated air to the outside for at least 48 hours

    - For facilities with central ventilation, increase air exchange rates for several days

18. Conduct medical monitoring for staff or patients that were exposed to high levels of mercury

19. Write a report on the spill incident and recommend improvements to prevent future spills

Managing a Mercury Spill

What NOT to do during a mercury spill

- Do NOT use a regular vacuum cleaner – it will spread more mercury vapors and will contaminate the vacuum cleaner
- Do NOT wash contaminated clothing or fabrics in a washing machine – it will contaminate the machine and wastewater
- Do NOT use a large broom to sweep mercury – it could break up mercury balls into smaller droplets
- Do NOT pour mercury down the drain – it will contaminate the plumbing system and septic or sewage treatment system for years to come
- Do NOT spread mercury with your shoes – use disposal shoe covers or decontaminate shoes

Mercury Spill Kits

- Prepare spill kits with all the items listed in the preceding slides
- Include a step-by-step clean-up procedure as a guide

- Place spill kits in readily accessible locations
- Train staff on the use of the spill kits
- Replace spill kit contents that have been used after every spill

Guidelines for an Interim Mercury Storage Site

- Siting
- Design
- Signage
- Containment of different types of mercury waste
- Storage practices

Siting

The area selected should be:

- Secure and restricted to prevent theft
- Readily accessible to mercury waste handlers
- Separate from regular or infectious waste storage areas
- Storage area should be kept cool with natural or forced ventilation and kept dry if using steel containers (< 40% humidity)

Design of the Storage Area

- Enclosed with roof and walls
- Locked door
- Proper size based on amount of waste to be stored plus space for materials movement
- Ventilation
  - Exhaust vent leads to the outside
  - Exhaust air is released away from people and crowded areas
  - Exhaust vent is not near any air intake vents
  - Ventilation control that can block air circulation back into the facility
  - Exhaust fan capable of (600/Q) air changes per hour where Q is the room volume in cubic meters in case of spill

Design of the Storage Area

- Seamless smooth flooring made of impervious material, for example:
  - Epoxy-coated cement
  - Polyurethane coated floor
  - Seamless rubber
  - Polyester flooring

- Bunding or spill containment tray on the floor below the waste containers
  - Volume of the spill tray or inside the bund wall should be at least 125% of the stored mercury volume

Design of the Storage Area

- Spill kit, PPE and wash area should be near (but not in) the storage area
- Personal protective equipment (PPE) should include:
  - Several pairs of rubber or nitrile gloves
  - Respiratory protection
  - Safety goggles or protective eyewear
  - Coveralls, apron, and other protective clothing
  - Disposable shoe covers

Signage and Labeling of Storage Area

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

Danger:
Hazardous Mercury Waste

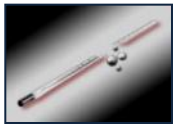
Containment of Mercury Waste

General principles

- Store mercury waste in primary and secondary containers
  - Primary container for the waste
  - Secondary container that prevents release of mercury if the primary container breaks

- Label the primary container; label the secondary container if it is not transparent
- Place a spill containment tray directly under the containers in storage

Containment of Mercury Waste: Examples



Containment of Mercury Waste: Examples

Storage Practices for Mercury Waste

- 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 spill kits. Spill kits should have a signed sheet indicating when they were used and replenished.

Storage Practices for Mercury Waste

- 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 in and around the storage space.

Storage Examples for Mercury Waste

Example 1: Small hospital

- Small quantities of old thermometers, 1 or 2 sphygmomanometers, some dental amalgam
  - Packaged using primary and secondary containers
- Storage :
  - Could be an old unused refrigerator in a locked room
  - “Danger: Mercury Waste” and poison symbol on refrigerator door
  - Fan stored by the window facing an empty yard
  - Plastic tray at the bottom shelf of the refrigerator
  - Cabinet with a spill kit, PPE, MSDSs, a copy of the inventory, and other records located outside the room

Storage Examples for Mercury Waste

Example 2: Large hospital

- 1000 unbroken thermometers
  - Taped thermometers placed with plastic bubble wrap in 3L stainless steel labeled can [primary container]
  - Can is placed in a 4L, 75 micron transparent sealable plastic bag [secondary container]
- 20 unbroken sphygmomanometers
  - Placed in original cases with labels [primary container] and taped together
  - Taped cases placed in 100 micron colored garbage bag with label [secondary container]

- 500 broken thermometers
  - Placed in a 3L stainless steel can with tight lid [primary container]
  - Can placed in a 4L 75-micron transparent sealable plastic bag [secondary container]

Storage Examples for Mercury Waste

Example 2: Large hospital (cont'd)

- 350 liters of non-sharp cleanup waste (rags, towels, etc.)
  - Placed in 75 micron sealable plastic bags with labels [primary container]
  - Bags placed in two 220L plastic drums with gasketed latching lid with outside label [secondary container]
- 40 ml of elemental mercury
  - Placed in a 100 ml wide-mouthed 0.3mm PET container with water [primary container]
  - Container placed in a 6ml transparent re-sealable bag on a spill tray [secondary container]
- 1.5 liters of dental amalgam
  - Placed in marked 2L PET bottle with dry vapor suppressant [primary container]
  - Bottle placed in 75 micron transparent resealable bag on a spill tray [secondary container]

Storage Examples for Mercury Waste

Example 2: Large hospital (cont'd)

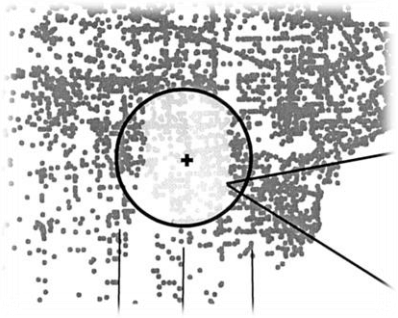
- 1,280 T8 fluorescent lamps
  - Placed in UN-approved, labeled drums
- Storage room:
  - 3 x 3 meter locked room in the basement
  - Basement is off-limits to patients and visitors
  - "Danger: Mercury Waste" and poison symbol on the door
  - In case of spill, exhaust fan on one wall is capable of 22 ACH; air blows out above the roof line facing an empty yard; mechanical damper plates in the AC vent can be closed
  - Smooth floor with polyurethane paint and flexible plastic bunding strip around area where mercury waste is stored
  - Cabinet with a spill kit, PPE, MSDSs, a copy of the inventory, and other records located outside the storage room

Considerations for Off-Site Transport

- Packaging requirements
- Special permit/license for transporter
  - Certified training, proof of liability insurance, submitted emergency response plans, spill kits, PPE, etc.
- 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
- Routing plan, contingency plan, emergency phone, etc.

Siting of an Interim Central Storage Facility

- At least 150 meters away from schools, hospitals, homes, food processing, agricultural operations, rivers or lakes, fisheries
- Secure area
- Accessible to vehicles transporting mercury waste



Design of an Interim Central Storage Facility

- Size based on maximum anticipated volume of mercury waste, plus shelving space, aisles, etc.
- Measures to withstand floods, earthquakes, typhoons, and other natural disasters
- Closely controlled access with an intrusion detection and alarm system
- Air conditioning to control temperature and humidity
- Heat, smoke and fire detection and alarm system, plus a fire suppression system

Design of an Interim Central Storage Facility

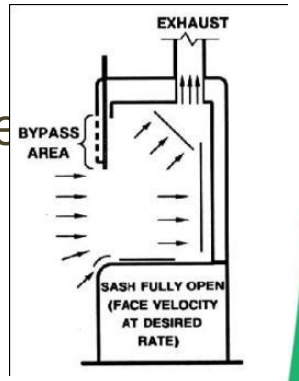
- At least four distinct and separate functional areas:
  - Receiving area for receiving and presorting waste, re-labeling if necessary, and signing documents
  - Inspection area for checking for leaks, repackaging, secondary containment, and re-labeling if necessary
  - Storage area specific for mercury waste
  - Administrative and record-keeping area

Design of an Interim Central Storage Facility

- Drains connected to a separate wastewater collection system
- Equipped with PPE, spill cleanup kits, first-aid medical supplies, and wash areas
- Receiving area
  - Signs
  - Presort table for incoming waste; a cart made of impervious material; spill kits; emergency containers for leaking containers; PPE; and a separate table or counter for documentation

Design of an Interim Central Storage Facility

- Inspection area
  - Engineered spill-control features including containment dike or bunding on the floor
  - Mercury vapor detection monitor or detection tubes
  - Local exhaust ventilation, such as a fume hood, connected to an activated carbon filter
  - Spill control tray or containment device over which the waste should be inspected
  - Emergency containers, packaging, labels, spill kits, and PPE



Design of an Interim Central Storage Facility

- Storage area
  - Warning signs on all doors
  - Continuous or periodic monitoring of mercury levels
  - Spill control features including floor sealant and containment dikes
  - Shelving and storage racks not above shoulder height
  - Lighting, aisle space, stacking, arrangements of containers, and labeling designed to facilitate inspection and future transport to terminal storage

Design of an Interim Central Storage Facility

- Storage area
  - Risk Level 1 (highest risk): elemental mercury, unbroken sphygmomanometers, and medical devices containing large amounts of mercury (gastro-intestinal tubes, esophageal dilators, etc.)
  - Risk Level 2: unbroken mercury thermometers, small mercury switches and small relays from electrical equipment
  - Risk Level 3: broken glassware contaminated with mercury, mercury cleanup waste
  - Risk Level 4: fluorescent lamps, compact fluorescent bulbs, dental amalgam
- Shelving and storage racks for Risk Levels 1 and 2 fitted with plastic containment trays

Other Considerations for Interim Central Storage

- Manifest system
- Licensing
- Hazardous waste management plan including storage and labeling guidelines, and staff training
- Periodic monitoring, weekly inspection, record-keeping, periodic reporting
- Health surveillance, medical monitoring of workers

Summary Points

- Redundancy in containment: primary container to prevent leaks, secondary container in case the primary container breaks, bund or tray underneath
- Use proper PPE when handling mercury
- Seek practical solutions consistent with the basic principles needed to protect health and environment while taking into consideration the specific situation in a facility

Resource: UNDP GEF Guidance Document

- GUIDANCE ON THE CLEANUP, TEMPORARY OR INTERMEDIATE STORAGE, AND TRANSPORT OF MERCURY WASTE FROM HEALTHCARE FACILITIES

Available from: www.gefmedwaste.org

Discussion

- How do you apply the hierarchy of mercury waste management to your facility?
- What elements of a mercury phase-out plan are appropriate for your facility?
- How would you modify the spill clean-up procedure for the particular situation in your facility?
- Discuss practical mercury containment and storage methods for your facility.
- What are your country specific requirements for mercury storage, treatment and disposal?