Eliminating Mercury in Hospitals

Environmental Best Practices for Health Care Facilities | November 2002

JCAHO Environment of Care Standards 1.3, 2.3, 4.0

How Pervasive and Harmful is Mercury in the Environment?

Mercury is a toxic pollutant and is listed as one of 12 priority chemicals by the EPA Persistent, Bioaccumulative, and Toxic (PBT) Chemical Program. Consuming fish from mercury-polluted water bodies can severely affect the central nervous system; impair hearing, speech and gait; and cause blindness, tremors, insomnia, emotional instability, paralysis, loss of muscular control, and even death.[1] Fish consumption advisories for mercury have been issued for thousands of water bodies nationwide, including all the Great Lakes and their connecting waters, more than 79,000 other lakes and more than 485,000 miles of rivers. In 2001, 49 states had issued mercury advisories for lakes, rivers, and other water bodies.[2]

Neonatal exposure to mercury has been linked to several serious birth defects and recent research suggests that prenatal effects occur at mercury intake levels 5 to 10 times lower than that of adults. Additionally, a National Academies of Science report from July 2000 showed that 60,000 children are born in the U.S. each year with neurological problems because of exposure to methylmercury in utero.[3]

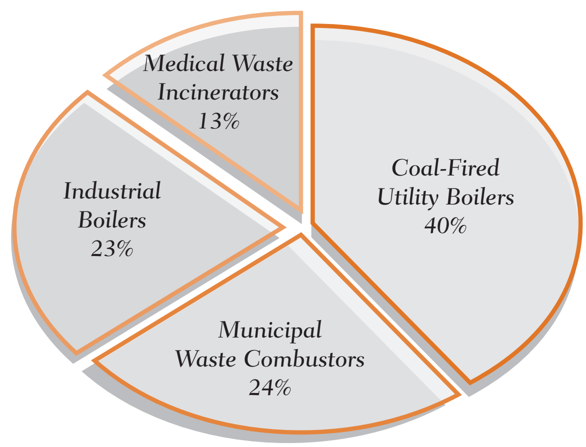
Numerous cases of mercury poisoning, primarily through inhalation, have been documented in the workplace. In a survey conducted by the National Institute for Occupational Safety and Health, researchers estimated that 70,000 American workers might be exposed to mercury vapors on the job, including nurses, lab technicians, and others working in health care facilities.[4] In addition, families of these workers were identified to be at risk of exposure from mercury-contaminated work clothes brought home by workers.[5]

Mercury Exposure Pathways

- *In utero*
- *Consuming mercury-contaminated fish*
- *Inhaling mercury vapors in the workplace*
- *Handling work clothes contaminated with mercury*

Atmospheric Mercury Contributions by Industry Sector

(1997, EPA)



What Are The Industrial Sources Of Mercury?

Although mercury is naturally occurring in volcanoes, natural deposits, and oceanic volatilization, human activities have substantially increased the amount of mercury cycling through the ecosystem. A 1997 EPA study[6] identifying industrial processes that contributed heavily to atmospheric mercury found that medical waste incinerators (MWI) contribute 13% (the fourth-largest source) of the anthropogenic mercury emissions to the environment. Additionally, hospitals contribute 4 to 5% of the total wastewater mercury load in some communities.[7] Many local wastewater treatment plants have identified hospitals as industrial pollution sources and have imposed strict wastewater limits for mercury (see Case Study 2). Eliminating or reducing mercury use not only lowers compliance costs, but also minimizes the potential for expensive spill cleanups.
(For more information on mercury sources and health effects, see www.h2e-online.org/about/mercury.htm.)

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Why Commit to Being Mercury-Free?

Public Health—

Hospitals most frequently commit to becoming mercury-free based on an ethical motivation to protect human health and the environment. This desire often supports the hospitals' mission statements which commonly include a goal of "assessing and improving community health." As significant users of products containing mercury, hospitals have an opportunity to play a key role in protecting public health by minimizing the use and release of mercury into the environment.

Regulations—

Mercury waste is regulated under the Resource Conservation Recovery Act (RCRA), which requires all hazardous waste handlers to have specially trained staff and equipment on hand in case of a spill or release. Additionally, these facilities must meet special storage, handling, disposal, waste tracking, and reporting requirements. Failure to meet any of these requirements can result in fines up to $25,000 per day.

By August 2002, over 300 health care facilities nationwide had already taken the "Hospitals for a Healthy Environment Pledge."

For more information see www.h2e-online.org

Voluntary Agreements—

Because of health care's contribution of mercury to the environment, EPA and the American Hospital Association (AHA) signed a memorandum of understanding in 1998 committing to the virtual elimination of mercury from hospitals by 2005.[8]

The following sections of this fact sheet present information about mercury-containing devices and chemicals, alternatives to mercury-containing products, vendor information, and case studies of successful mercury elimination programs. This fact sheet also contains links to other important resources for completing a mercury inventory, setting up a mercury elimination program, and taking the steps necessary to eliminate mercury at your hospital.

Two recent independent studies[10, 11] have found significant accuracy problems associated with mercury thermometers:

- *25% of new mercury thermometers were inaccurate by at least ± 0.2 degrees C*
- *28% of mercury thermometers were inaccurate by at least ± 0.1 degree C*

[The ASTM standard for glass/mercury medical thermometers specifies a maximum allowable error of ± 0.1 C in the cited range.]

Mercury Thermometers: Prone To Inaccuracies

Mercury Sphygs: Worthy of Gold Standard Status?

A study[12] of 444 mercury sphygs found:

- *55% showed zero level between 10 and 20 mm Hg*
- *38% had dirty columns that obscured readings*
- *20% of the columns were not vertical*
- *5% had blocked air filters*
- *3 units had visible mercury droplets outside the mercury tube*

[1] EPA Mercury White Paper. www.epa.gov/ttn/oarpg/t3/memoranda/whtpaper.pdf
[2] EPA Listing of Fish and Wildlife Advisories. May 2002. www.epa.gov/waterscience/fish/
[3] National Academies of Science, National Research Council. July 2000. "Toxicological Effects of Methylmercury."
[4] Anne Nadakavukaren. "Our Global Environment: A Health Perspective". 1995.
[5] Guy Williams. "Mercury Pollution Prevention in Healthcare." National Wildlife Federation. July 1997.
[6] EPA. EPA-452/R-97- 004. "Mercury Study Report to Congress, Volume II: An Inventory of Anthropogenic Mercury Emissions in the United States". December 1997.
[7] "Making Medicine Mercury-Free: A Resource Guide for Mercury-Free Medicine." Health Care without Harm. 2001.
[8] Health Care Without Harm, in partnership with the U.S. Environmental Protection Agency, the American Hospital Association and the American Nurses Association, has launched Hospitals for a Healthy Environment (H2E). www.h2e-online.org

Where Is Mercury Found in Hospitals?

Although mercury is found in many places within hospitals, a mercury elimination plan should include a prioritized list of targets. For example, the California Department of Health Services (CA DHS)[9] conducted mercury inventories at six northern California hospitals in 1999 and found that sphygmomanometers and gastroenterology instruments accounted for 89 percent of the mercury in these hospitals.

Most mercury-containing equipment have a mercury-free alternative. Although some mercury-free alternatives may initially cost more, facilities often find that their initial capital costs are outweighed by the total costs associated with mercury cleanup equipment, spill costs and liabilities, and handling and disposal costs and liabilities (see Table 1, page 5).

Mercury can be found in many commonly-used hospital devices and materials including:

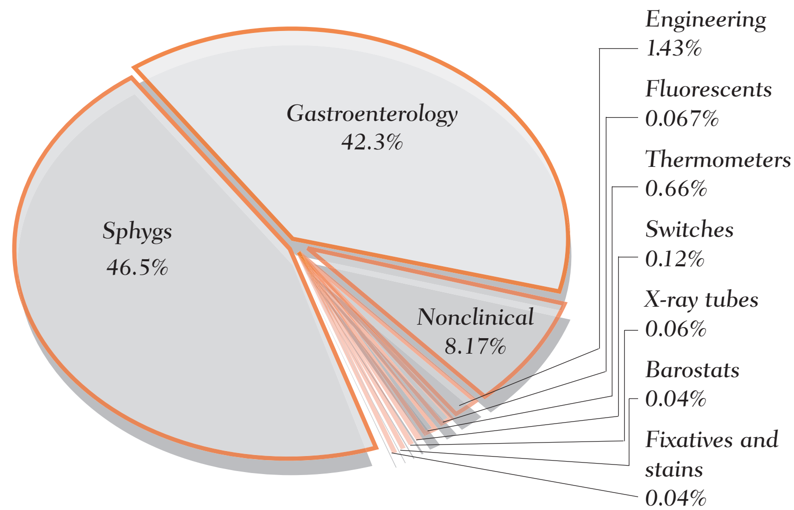
Thermometers

- Contain about 0.5 gram of mercury (laboratory thermometers contain 2 to 10 grams of mercury)
- Generally account for a small percentage of total mercury at hospitals

continues

- An important source of mercury contamination of nonhazardous waste streams because they are often disposed of improperly
- In contact with staff and patients more than any other medical device
- Broken thermometers inappropriately disposed of in red bags or sharps containers may be incinerated and release mercury into the environment
- A UCLA Medical Center study found that broken mercury thermometers were the most common sources of mercury spills—accounting for over 55% of incidents
- Alternatives are readily available (see thermometer inset that contains detailed data on the efficacy, cost, and features of both mercury and mercury-free fever thermometers)

Mercury Sources in Seven Northern California Hospitals
(California Department of Health Services, September, 2000)



Sphygmomanometers (blood pressure monitors)

- Contain 70 to 90 grams of mercury
- Typically located in heavily used areas including patient rooms, waiting areas, triage centers, and offices where the potential for patient or health care worker exposure to mercury is high
- The equipment at hospitals that often contain the largest amount of mercury
- Without regular maintenance, mercury sphygs can be inaccurate
- Alternatives are readily available (see sphyg insert that contains detailed data on the efficacy, cost, and features of both mercury and mercury-free sphygs)

Cantor and Miller Abbot tubes (also called esophageal bougies and Sengstaken-Blakemore tubes)—Used to clear gastrointestinal [GI] restrictions

- The equipment at hospitals that often contain the second largest concentration of mercury
- A single set of bougie tubes can contain up to 454 grams of mercury
- FDA device failure database shows 58 incidents from 1991 to 2000 in which GI tubes broke and released mercury inside patients[13]
- Alternatives are readily available; some substitutes are weighted with air or water while others are preweighted with tungsten; because the mercury in GI tubes functions as a weight, rather than a measurement device, the performance of alternatives is less questionable, and tungsten-weighted devices are considered just as effective
- Additionally, tungsten-weighted alternatives have the advantage of being opaque in X-rays, allowing detection of the dilator as it moves through the body

Non-Clinical Mercury Sources (sphyg repair kits, barometers, switches, etc.)

- Barometers contain about 800 grams of mercury and can be replaced with a 1-millibar precision aneroid for less than $250 or simply rely on a local airport or weather station for data
- Eliminating mercury sphygs renders a repair kit containing mercury obsolete

Other Sources

- Staining solutions and laboratory reagents (thimerosal, mercury chloride, immusal, and carbol-fuchin) Check the mercury content of your chemical at www1.netcasters.com/mercury/
- Tissue fixatives (Zenker's solution and B5)
- Thermostats
- Batteries
- Manometers on medical equipment
- Esophageal dilators (also called Maloney or Hurst bougies)
- Fluorescent and high-intensity lamps
- Cleaning solutions

continues

Taking the Leap....

How do you get a mercury reduction program rolling? Here's a step-by-step plan for making mercury reduction a priority at your hospital (also see Case Study 1, page 6):

Step 1 - Make A Commitment

Get support from the top. Talk to your hospital leadership, and get a signed statement to be mercury-free.

Establish a mercury-free team. Designate a program leader who will be enthusiastic and dedicated to the program and would identify a person in each department who has the authority to make departmental changes in order to build support.

Step 2 - Conduct A Mercury Inventory

Create a baseline inventory of mercury-containing products in your hospital against which progress can be measured.

Mercury inventory tools are widely available on the Internet. The Mercury Assessment Toolkit produced by the CA DHS is particularly comprehensive, easy to adapt to hospital-specific conditions, easy to use, and tracks reductions automatically.
See www.dhs.ca.gov/ps/ddwem/environmental/med_waste/medwasteindex.htm for additional information.

Step 3 - Evaluate Alternatives

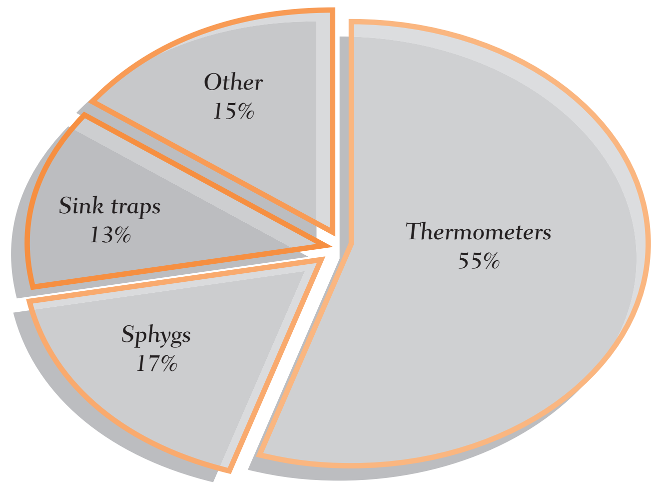
Evaluate mercury-free alternatives in the context of your hospital.

- Is the performance comparable?
- What is the purchase cost for alternatives? For accessories? For maintenance?
- Are these costs offset by lower handling, disposal, and liability costs?

Contact the vendors listed at the end of this fact sheet for more information on mercury-free alternatives to common hospital devices, or check out these web sites: www.sustainablehospitals.org and abe.www.ecn.purdue.edu/~mercury/src/devicepage.htm

UCLA Mercury Spill Frequency (1997-1999)

(average of 18 mercury spills per year)



- Spill cleanup costs: Labor: approximately $10,000/year
  Disposal: approximately $34/pound
- 42% of the hazardous material unit incidents involved mercury
- Hazardous material unit spent 90 hours/year responding to mercury-related spills
- Hazardous material team cost $100 per hour resulting in a labor cost alone of $28,059 for the 3-year period

Step 4 - Establish Goals And Implementation Plans

Set short-term, measurable goals that match your hospital's resources. Reasonable goals, such as the elimination of mercury sphygmomanometers within 2 years, are easily measured and proposed as part of a hospital's business plan. Once attained, the goals can provide a springboard for new mercury reduction projects.

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Matching Mercury Replacement Strategies with Budgets

Targeted Device	Financially Strapped	Capital Budgets Allocated
Sphygmomanometers	Replace at servicing intervals	Replace as many as possible with available funding, then phase out remaining devices when broken
Gastrointestinal Tubes	Replace when expired	Replace immediately
Thermometers	Replace a set percentage each quarter or year targeting departments with high breakage first	Implement a one-time mass replacement

Step 5 - Institute Best Management Practices

- Educate staff regarding the hazards of mercury and proper handling and disposal.
- Eliminate mercury-containing equipment and products.
- Establish and monitor mercury-free purchasing policies.

Step 6 - Measure Success

Use your mercury inventory (from Step 2) to re-evaluate your facility. Identify your successes and modify your plan as necessary. Most importantly, get the message out to hospital staff members that they are making a difference!

Step 7 - Keep The Mercury Out

Work with your purchasing department to make sure that mercury products do not find their way back into the hospital. Require vendors to disclose the mercury content of products that you intend to purchase. See "Tools for Change" at www.sustainablehospitals.org for an example of a vendor product mercury-content disclosure agreement and mercury-free purchasing policy language.

(Table 1)

Mercury Spill Training and Equipment[13]

Training	Cost
Trainees (3 employees x 2 hrs x $15/hr)	$90 + loss of productivity
Trainer (2 hrs x $20/hr)	$40 + loss of productivity

Equipment	Cost
Spill Kit and Draeger Mercury Sniffer	$519

Total Cost: $649

Mercury Spills

Depending on the type and size of the spill and the facility, mercury cleanups at hospitals are sometimes handled by staff if they are trained and available, or otherwise addressed by cleanup contractors. While mercury spill data from a wide variety of health care facilities including large and small, urban and rural, emergency, research and clinical facilities are generally unavailable or incomplete, the best available data comes from a large hospital at the University of California, Los Angeles (UCLA) between 1997 and 1999 (see summary on previous page).

What Does It Cost To Prepare For and Clean Up Mercury Spills?

Because of health and safety considerations and the environmental impact of mercury, any hospital that stores and uses mercury-containing devices within its facility is required by federal regulations to be prepared to handle mercury spills. Table 1 shows costs for mercury spill training and equipment that a hospital *will incur*, and Table 2 lists liability costs that a hospital *might incur*. Actual cleanup costs for several spill scenarios are itemized in the sphyg and thermometer inserts.

(Table 2)

Human Health and Environmental Liability

Exposures, Workers' Compensation, Lost Time, and Lawsuits	*Case-specific*
Fines and Lawsuits for Improper Cleanups And Disposal	*Up to $75,000 + possible jail sentence*

[9] California Department of Health Services. 2000. A Guide to Mercury Assessment and Elimination in HealthCare Facilities. www.dhs.ca.gov/medicalwaste

[10] Leick-Rude, M.K. and Bloom, L.F. 1998. A Comparison of Temperature-Taking Methods in Neonates. Neonatal Network. Volume 17. Number 5. Pages 21-37.

[11] Mayfield, S. R. et al. 1984. Temperature Measurements in Term and Preterm Neonates. Journal of Pediatrics. Volume 104. Number 2. Pages 271-275 as cited in Leick-Rude, M.K. and Bloom, L.F. 1998.

[12] N.K. Markandu, F. Whitcher; A. Arnold and C. Carney. "The Mercury Sphygmomanometer Should Be abandoned Before it is Proscribed." Journal of Human Hypertension. Volume 14, pages 31 through 36. 2000.

[13] Holly J. Barron. HealthSystem Minnesota Mercury Reduction "MnTAP Intern Project Report." 2000.

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The following three case studies are summarized in terms of "Impetus," "Actions," and "Results" to help identify the challenges faced by hospitals and the solutions they employed to start eliminating mercury. While each hospital is unique, these case studies may help you anticipate hurdles and estimate costs associated with mercury elimination.

case study 01 | Mercury Costs Prompt Elimination Program in Rochester, NY

Impetus: The 750-bed Strong Memorial Hospital (SMH) is the primary teaching hospital of the University of Rochester Medical School and is a regional trauma center. Since 1997, SMH has implemented a focused mercury reduction plan to eliminate the problems associated with spill response, disposal, and training.

Actions:

Executive involvement and support:

- SMH signed a memorandum of understanding with the Monroe County Health Department
- CEO assigned program personnel and resources

Staff training and involvement:

- Trained staff in program objectives and mercury awareness
- Multidisciplinary teams identified mercury-containing devices and mercury use
- Developed a mercury training poster for newly hired nurses
- Developed and distributed a mercury use and disposal pamphlet
- Added a mercury-specific training unit to the annual Resource Conservation Recovery Act (RCRA) training, including a "show-and-tell" for different mercury-containing items encountered during routine maintenance
- Included questions on Joint Commission on Accreditation of Healthcare Organization (JCAHO) safety surveys about proper mercury disposal and a check box noting the presence of mercury-filled sphygs
- Added a hazardous materials section (including mercury) to the project manager's renovation and construction manual

Mercury Collection:

- Developed and implemented procedures to improve staff use of mercury collection facilities including:
  - Placing specially-labeled collection containers for mercury thermometers within patient care units
  - Adding labels on or near sharps containers to remind staff members not to place thermometers in the medical waste containers
  - Establishing easy-to-access battery drop-off locations
  - Establishing a centralized collection point for used fluorescent lamps

Year	Thermometers	Sphygs
Pre-1997	9,444	900
1997	7,706	500
2001	524	0

Results:

- Replaced all mercury sphygs
- Reduced mercury thermometer use by over 90% – encountered difficulty replacing thermometers in the neonatal intensive care unit due to infection control concerns
- SMH's program cited as an example of a quality improvement initiative during the 1998 JCAHO survey
- Eliminated annual disposal of 45 pounds of mercury-filled GI tubing by purchasing only tungsten-filled GI tubing since the program began
- Histopathology and other clinical laboratories discontinued use of mercury compounds

case study 02 | Wastewater Violations Force Change in Boston, MA

Impetus: Beth Israel Deaconess Hospital began its mercury reduction program in 1993 when the local sewer district lowered mercury limits in industrial wastewater to 1 part per billion (ppb) resulting in subsequent fines of $118,000 for exceedences. Beth Israel's wastewater contained approximately 360 ppb mercury.

Actions:

- Trained staff on mercury sources and proper disposal methods, posted wastewater data, and changed the collection process for mercury-laden chemicals including the fixatives B5 and Zenker's solution
- Infrastructure upgrades: cleaned traps and pipes
- End-of-pipe treatment: installed a sand filter ($40,000) and a dewatering unit ($60,000) both requiring minimal maintenance
- Instituted a wastewater sampling program to establish a baseline for measuring its progress

Results: (Baseline Wastewater Mercury Content: 360 ppb mercury)

- Training, awareness and lab chemical replacement reduced mercury content to 100 ppb
- Trap and pipe cleaning reduced content to 4–8 ppb
- Improved wastewater treatment reduced content to < 1 ppb

case study 03 | Spills Prompt Mercury-Free Commitment in Grand Rapids, MI

Impetus: Butterworth Hospital with 529 beds made a commitment to eliminate mercury after three separate mercury spills cost the hospital over $6,000. In 1995, the hospital estimated that there was 1.5 pounds of mercury per bed.

Actions:

- Replaced all existing sphygs and esophageal dilators containing mercury
- Instituted a policy banning the purchase of mercury-containing thermometers, sphygs, esophageal dilators, and batteries

Results:

- Removed 300 pounds of mercury
- No longer sends mercury-containing devices overseas as part of its humanitarian efforts

continues

Resources

Mercury-Free Thermometers

Alaris/IVAC
(800) 854-7128
www.alarismed.com

Braun
(800) 327-7226

Geratherm
(888) 596-9498
www.1thermometer.com

Medical Indicators
(888) 930-4599
www.medicalindicators.com

*Omron Healthcare**
www.omron.com/ohi

Welch Allyn
www.welchallyn.com

3M Healthcare
(800) 228-3957
www.3m.com/healthcare

Mercury-Free Sphygmomanometers

*Alco Classic**
(800) 323-4282

American Diagnostic Corporation
(631) 273-9600
www.adctoday.com/

*Omron Healthcare**
www.omron.com/ohi

Tips On Procurement

www.state.ma.us/ota/pubs/epp-march01.htm#/tips

Trimline
(800) 526-3538
www.trimlinemed.com

W.A. Baum
(888) 281-6061
(631)226-3940

*Welch Allyn**
www.welchallyn.com

Mercury-Free Gastrointestinal Devices

Miller Abbot Tubes

Anderson
(800) 523-1276, x 292

Bard Medical Services
(800) 227-3357

Rusch
(800) 553-5214
www.ruschinc.com

Bougie Tubes

Pilling
(800) 523-6507

Cantor Tubes

Anderson
(800) 523-1276, x 292

Mercury-Free Vital Signs Monitors

Alaris
(800) 854-7128
www.alarismed.com

Welch Allyn
www.welchallyn.com

Mercury-Free Laboratory Chemicals

For alternatives see the list at www.sustainablehosptals.org

Consider taking the “Hospitals for a Healthy Environment Pledge.” Find out more at www.h2e-online.org

* Companies with a mercury exchange program to help defray the cost of replacing mercury-containing devices.

See www.state.ma.us/ota/pubs/eppmarch01.htm#tips for tips on procuring non-mercury sphygmomanometers.

Sphygmomanometer Cost Comparison[13]

Sphygmomanometer Cost Comparison

Costs Over 5-Year Period

	Mercury Unit	Aneroid Unit		Electronic Unit
		Wall Unit	Mobile Unit	Vital Signs Monitor
Purchase and Training				
Purchase Cost[14]	$129	$152	$264	$1,250 to $3,000
Batteries	NA	NA		$30
Training[15]	$20	$20		$80
Calibration				
Biomedical Engineer (15 minutes/calibration x $40/hour) = $10/calibration	$100[16] (every 6 months)	$100[16] (every 6 months)		$10 (every 5 years or if damaged)
Storage, Handling and Cleanup				
Shipping, Handling and Disposal[17]	$34 as hazardous waste	$0.03 as solid waste		$.017 as solid waste
Mercury Spill Training and Equipment (see table below)	$649	NA		
5-Year Usage Cost Totals	$932	$272	$384	$1,370 –$3,120

Mercury Sphygmomanometer Spill Cleanup Costs[18]

Hard Floor/Early Detection	Mercury Spill Kit	$325
	3 Hours of Staff Time	$45
	Disposal Of 5-gallon Bucket	$620
	Total	$990
Hard Floor/Late Detection	Mercury Spill Kit	$325
	10 Hours of Staff Time	$150
	Disposal Of 5-gallon Bucket	$620
	Total	$1,095
Carpeted/Early Detection	Mercury Spill Kit	$325
	10 Hours Staff Time	$150
	27 Sq. Ft. Carpet Replacement	$48
	Disposal Of 55-gallon Drum	$1,000
	Total	$1,523
Carpeted/Late Detection	Mercury Spill Kit	$325
	20 Hours Staff Time	$300
	90 Sq. Ft. Carpet Replacement	$160
	Disposal Of 55-gallon Drum	$1,000
	Total	$1,785
	Average Cost per Spill[18] =	$1,539

[13] Unless noted, costs are from Holly J. Barron. HealthSystem Minnesota Mercury Reduction "MnTAP Intern Project Report." 2000.

[14] Purchase costs are for mercury-free sphygs: Welch Allyn wall unit, Trimline mobile unit , and Alaris/IVAC vital signs monitor (4200 or 4400 Series)

[15] Trainee (4 employees x 0.25 hour x $15/hour); trainer (0.25 hour x $20/hour); 1 hour training for vital signs monitor

[16] Assumes one 15 minute calibration takes place every 6 months over the 5 year period (15 min/calibration x $40/hour x 2 calibrations/year x 5 years).

[17] Varies by region; hazardous waste ($34 per pound or $895 - $1,200 per 55 gallon drum); solid waste (approx. $0.03 per pound, or $68 per ton); see www.epa.gov/epaoswer/non-hw/recycle/recmeas/docs/guide_b.pdf)

[18] Average for 13 mercury sphygmomanometer spills

Sphygmomanometer Efficacy

Sphygmomanometer Efficacy	Mercury	Aneroid	Vital Signs Monitor
Accuracy	• +/- 3 mm Hg conforms to AAMI standards • Operator must understand and account for mercury meniscus • Oxidized mercury can make the column appear dirty and make readings difficult	• +/- 3 mm Hg conforms to AAMI standards • Includes a self-bleeding deflation valve for increased reading accuracy	• +/- 3 mm Hg conforms to AAMI standards • Digital display removes operator error and bias • Automatic deflation rate improves accuracy
Calibration	• Required every 6 months • Adjusted only at the zero point	• Required every 6 months • Requires specialized tools and technical skills to calibrate the mechanism at several pressure points, including zero	• Recommended every 5 years or if the device has been dropped • Usually provided at no cost by the manufacturer
Installation	• Mercury tube must be perfectly vertical in its unit and perpendicular to the ground	• No specific orientation required	• No specific orientation required
Use	• Requires excellent technique to read the meniscus of a mercury column	• Easier to read than mercury column	• Digital display standardize measurements • Automatic inflation and deflation improves staff efficiency
Maintenance	• Without proper maintenance, accuracy of the device could be considerably diminished • Frequent filter replacement needed to avoid mercury column “lag,” a delay in mercury response, that contributes to inaccuracies	• Easy to see if aneroid needle is off zero when not in use • Calibration is harder than with mercury units	• Battery replacement as necessary (approximately every 350 uses)
View Window	• 0 to 300 mm Hg with no stop pin	• 0 to 300 mm Hg with no stop pin	NA
Measurement Technique	• Relies on the auscultatory technique	• Relies on the auscultatory technique	• Relies on oscillometric technique
Other Features	——	——	• Unit can also measure temperature, pulse rate, blood pressure

AAMI - Association for the Advancement of Medical Instruments
mm Hg = millimeter mercury column

Thermometer Cost Comparison

Fever Thermometer Cost Comparison[13]

Costs Over 5-Year Useful Life (estimate 35,000 uses; approximately 20/day)

	Mercury	Liquid-In-Glass	Digital	Tympanic	Dot Matrix/single use
Purchase/Training					
Purchase Cost[19]	$2.00	$13.75	$180	$296	$3,500
Probe Covers[20]	NA	NA	$1,960 ($28 per 500)	$2,100 ($30 per 500)	NA
Batteries ($5 x replaced every 5,000 uses)	NA	NA	$35	$35	NA
Training	NA	NA	$20[21]		NA
Calibration					
Biomedical Engineering (15 min/calibration x $40/hour)	NA	NA	$70[22]	NA	NA
Storage/Handling/ Cleanup					
Shipping, Handling and Disposal[17]	$45.00 as hazardous waste	<$0.01 as solid waste	$0.02 as solid waste	$70.02 as solid waste	$3.00 as solid waste
Mercury Spill Training and Equipment (see table below)	$649	NA			
5-Year Cost	**$695**	**$13.76**	**$2,265**	**$2,511**	**$3,503**

Mercury Thermometer Spill Cleanup Costs

Hard Floor/ Early Detection	Mercury Spill Kit	$195
	3 Hours of Staff Time	$45
	Disposal of 5-gallon Bucket	$620
	Total	$860
Hard Floor/ Late Detection	Mercury Spill Kit	$195
	10 Hours of Staff Time	$150
	Disposal of 5-gallon Bucket	$620
	Total	$965
Carpeted/ Early Detection	Mercury Spill Kit	$195
	10 Hours of Staff Time	$150
	27 Sq. Ft Carpet Replacement	$48
	Disposal of 55-gallon Drum	$1,000
	Total	$1,393
Carpeted/ Late Detection	Mercury Spill Kit	$195
	20 Hours of Staff Time	$300
	90 Sq. Ft Carpet Replacement	$160
	Disposal of 55-gallon Drum	$1,000
	Total	$1,655

Average Number of Breakages/Year[23] = 3.4 per 100 beds
Average Cost/Spill[24] = $270

[13] Unless noted, costs are from Holly J. Barron. HealthSystem Minnesota Mercury Reduction "MnTAP Intern Project Report." 2000.

[17] Varies by region; hazardous waste ($34 per pound or $895 to $1200 per 55-gallon drum); solid waste (approx. $0.03 per pound, or $68 per ton); see www.epa.gov/epaoswer/non-hw/recycle/recmeas/docs/guide_b.pdf)

[19] Purchase and disposal cost for mercury and liquid-in-glass thermometers is for five thermometers (replaced once per year); digital and tympanic thermometer is for one unit; dot matrix are single use and cost $10 per 100; liquid-in-glass thermometer purchase cost from Geratherm

[20] Average taken from various medical suppliers

[21] Trainee (4 employees x 0.25 hour x $15/hour); trainer (0.25 hour x $20/hour)

[22] Assumes one 15 minute calibration takes place every 9 months over the 5 year period (15 min/calibration x $40/hour x 6.66 calibrations/5 years).

[23] Average breakage data for four facilities.

[24] Average provided by major SF Bay Area Medical Center

Thermometer Efficacy

Thermometer Efficacy

	Mercury	Liquid-in-Glass	Digital	Tympanic	Dot Matrix
Accuracy (see below for ASTM standards)	Requires some skill to account for meniscus in reading	Requires some skill to account for meniscus in reading	Digital display standardizes measurements, eliminating user error	Digital display standardizes measurements, eliminating user error	Easier to read than a mercury column
Time Required For Reading	Oral - 3 minutes Rectal - 3 minutes Axillary - 4 minutes	Oral - 3 minutes Rectal - 3 minutes Axillary - 4 minutes	Oral - 4 seconds Rectal - 15 seconds Axillary - 10 seconds	Ear - 1 second	Oral - 1 minute Axillary - 3 minutes
Calibration	NA	NA	NA	6 – 12 months	6 – 12 months
Temperature Range	94 to 108°F	94 to 108°F	84 to 108°F	Varies significantly	96 to 104.8°F
Battery	NA	NA	3 AA alkaline cells good for 5,000 to 6,000 readings	3-volt lithium or 9-volt alkaline good for 5,000 to 8,000 readings	NA
Other Considerations	• Often not left in place long enough to obtain accurate reading • Can be easily broken as a result of rectal perforation, especially for neonates and young children		• Quick, accurate readings • Minimally invasive - works well with children • Requires probe covers for hospital use		• Single use prevents cross-contamination • Single use increases waste generation • Ideal for isolation patients

Medical thermometers are tested to voluntary standards set by the American Society for Testing and Materials (ASTM) and shown in following table. There are non-mercury alternatives that meet these standards — ask your vendor whether the non-mercury alternative you choose for your facility meets the ASTM standards for its class.

Mercury in Glass – ASTM E667-86
Electronic – ASTM E-1112-86

Range	< 96.4°F	96.4° to 98.0°F	98.0° to 102.0 °F	< 102.0° to 106.0°F	> 106°F
Max. error allowed:	±0.4°F	±0.3°F	±0.2°F	±0.3°F	±0.4°F
Max. error allowed:	±0.5°F	±0.3°F	±0.2°F	±0.3°F	±0.5°F