909E02001

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]

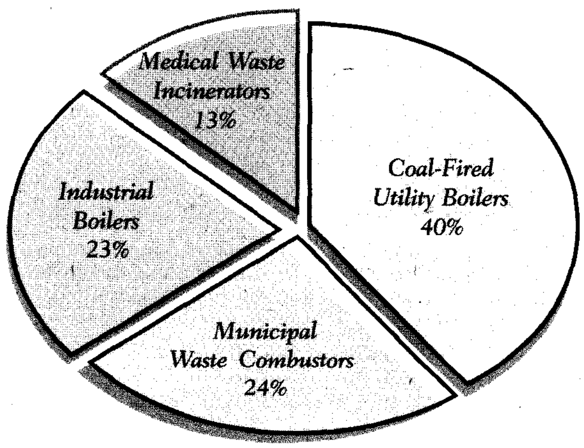
Neonatal exposure to mercury has been linked to several serious birth defects and recent research suggests that prenatal effects occur at mercury intake levels 5 to 10 times lower than that of adults. Additionally, a National Academies of Science report from July 2000 showed that 60,000 children are 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 cares 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.

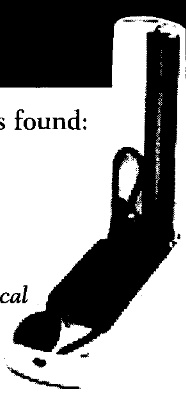
Two recent independent studies[10,11] have fund significant accuracy problems associated with mercury thermometers:

- *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:

Mercury Sphygs:



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:

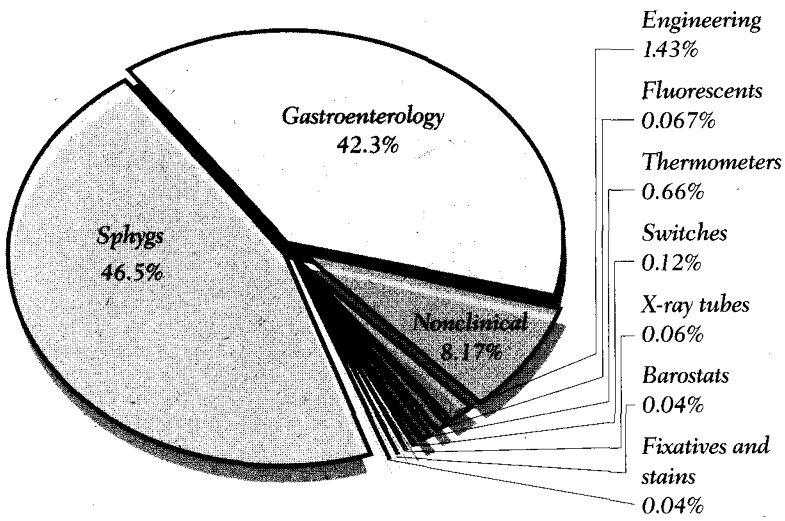
Thermometers

- 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 (Zenkers 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? Heres 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.

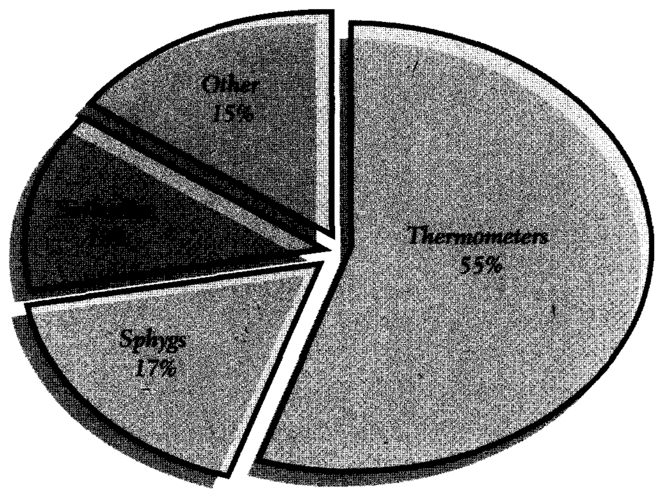
Step 3 - Evaluate Alternatives

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 hospitals resources. Reasonable goals, such as the elimination of mercury sphygmomanometers within 2 years, are easily measured and proposed as part of a hospitals 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

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

Sphygmomanometer Cost Comparison[13]

Sphygmomanometer Cost Comparison

Costs Over 5-Year Period

	Mercury Unit	Aneroid Unit Wall Unit	Aneroid Unit Mobile Unit	Electronic 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 –$3120

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

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

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

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.

Human Health and Environmental Liability
Case-specific
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.

continues

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

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 02 | 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

* 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.

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Using Microfiber Mops in Hospitals

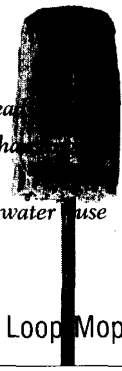
Environmental Best Practices for Health Care Facilities | November 2002

JCAHO Environment of Care Standards 1.3, 2.3, 4.0

Why Consider Alternative Mopping Techniques?

Using conventional loop mops for wet mopping of patient care areas has long been the standard in floor cleaning for janitorial operations in hospitals. However, the health care industry has taken a recent interest in evaluating hard floor maintenance techniques in terms of employee, patient, and environmental health. Many floor cleaners used in hospitals contain harsh chemicals such as quaternary ammonium chlorides and butoxyethanol, which can be harmful to human health and the environment. To reduce the risk of cross-contamination for patients, conventional mopping techniques require janitors to change the cleaning solution after mopping every two or three rooms—meaning that cleaning solutions (including both chemicals and several gallons of water) are constantly being disposed of and replenished.

Some facilities have begun using a new mopping technique involving microfiber materials to clean floors. Microfibers are densely constructed, polyester and polyamide (nylon) fibers that are approximately 1/16 the thickness of a human hair. The density of the material enables it to hold six times its weight in water, making it more absorbent than a conventional, cotton loop mop. Also, the positively charged microfibers attract dust (which has a negative charge), and the tiny fibers are able to penetrate the microscopic surface pores of most flooring materials. These characteristics make microfiber an effective mopping material; the following case study provides detailed information to help your hospital evaluate the possibility of using microfiber mops.



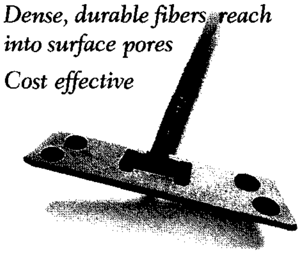
- *Large, heavy mop heads*
- *Requires frequent changes of cleaning solution*
- *High chemical and water use*
- *Labor intensive*

Conventional Wet Loop Mops

VS.

Microfiber Mops

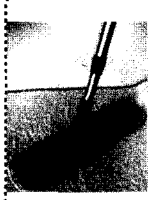
- *Light and ergonomic*
- *Prevents dirty mop heads from contaminating cleaning solution*
- *Dense, durable fibers reach into surface pores*
- *Cost effective*



case study | Mopping Up Savings at UC Davis

The University of California Davis Medical Center (UCDMC) in Sacramento, CA, had three motivations for changing the way its custodial staff maintained the floors in patient care areas:

- **Reduce chemical use and disposal.** Conventional wet mopping practices require cleaning solution changes after every third room to reduce patient health risks from cross-contamination.
- **Reduce cleaning times for patient rooms.** Conventional wet mopping practices—including mopping the floor, preparing and changing the cleaning solution, and wringing the mop before and after jobs–take approximately 15 minutes for a typical patient room.
- **Reduce custodial staff injuries and workers' compensation claims.** Conventional wet mopping practices can lead to custodial staff injuries through the repeated motions of mopping and wringing.



Microfiber Mops
- are less work-intensive than conventional mops,
- virtually eliminate cross-contamination during janitorial tasks, and
- drastically reduce chemical and water use while cleaning more effectively.

The environmental staff at UCDMC identified MicroScrub® microfiber mops as a potential alternative to conventional mops that might reduce costs. However, before changing the floor maintenance techniques, the environmental staff had a few obstacles to overcome. For example, the custodial staff was somewhat averse to change and was unconvinced that the microfiber mops would be as effective. Other hospital personnel, such as nurses and doctors, and even patients also shared this concern.

continues

Reasons for Change

Although change is never easy, the environmental staff worked with custodial supervisors to communicate the personal benefits of using microfiber mops in place of a conventional mop. There were two characteristics that helped alleviate the concerns of the custodial staff. First, the microfiber mops weigh approximately five pounds less than conventional wet loop mops, making them much easier to use. Second, the microfiber mop head is changed after every room is mopped, benefiting the custodial staff in two ways: 1) the effort of wringing a conventional mop is eliminated, and 2) as long as the used mop head is not put back in the cleaning solution, the custodian does not have to change the solution between rooms. The latter feature was particularly attractive, as a full bucket of cleaning solution can weigh 30 pounds or more and has to be lifted an average of seven times a day. Both characteristics have significantly reduced labor costs. Moreover, because the same mop water is not being shared between rooms, microfiber mopping virtually eliminates the cross-contamination risk that floor mopping can pose for patients.

To address concerns regarding the effectiveness of the microfiber mops, the environmental staff performed demonstrations in which an area would first be cleaned with a conventional mop and then re-cleaned with a microfiber mop. In each case, the microfiber mop would capture more dust and dirt. However, when the same test was done in reverse order, the conventional mop was not able to capture more dust and dirt beyond the capabilities of the microfiber mop.

Cost comparisons between conventional wet loop mops and microfiber mops for UC Davis Medical Center

	Microfiber Mop	Conventional Wet Loop Mop
Mop Costs		
Cost:	$17.40 each	$5.00 each
Washing Lifetime:	500 to 1000[1]	55 to 200[2]
Rooms Cleaned Per Washing:	1	22
Cost Total:	$1.74 to $3.48 per 100 rooms	$.11 to $.41 per 100 rooms
Labor Costs		
Rooms Cleaned Per Day:	22 per eight hour shift	20 per eight hour shift
Labor Cost:	$12 per hour	$12 per hour
Cost Total:	$436 per 100 rooms	$480 per 100 rooms
Chemical Costs		
Quantity of Chemical:	0.5 ounce per day	10.5 ounces per day
Cost of Chemical:	$.22 per ounce	$.22 per ounce
Rooms Cleaned Per Day:	22	20
Cost Total:	$0.50 per 100 rooms	$11.55 per 100 rooms
Water Use		
Quantity:	1 gallon	21 gallons
Rooms Cleaned:	22	20
Cost Total:	5 gallons per 100 rooms	105 gallons per 100 rooms
Electricity Usage (Washing)		
Cost:	$.030 per mop	$1.00 per mop
Cleaning Frequency:	once per room	once per day
Cost Total:	$30 per 100 rooms	$5 per 100 rooms
	>> Total Costs <<	
	$468 to $470 per 100 rooms per day	**$497 per 100 rooms per day**
	>> Microfiber mops use 95% less water and chemicals <<	

[1] Vendors guarantee microfiber mop heads for 500 washings; UCDMC typically used mop heads for over 1,000 washings.
[2] Vendors estimate conventional wet loop mops to last 55 washings; UCDMC replaced them after 200 washings.

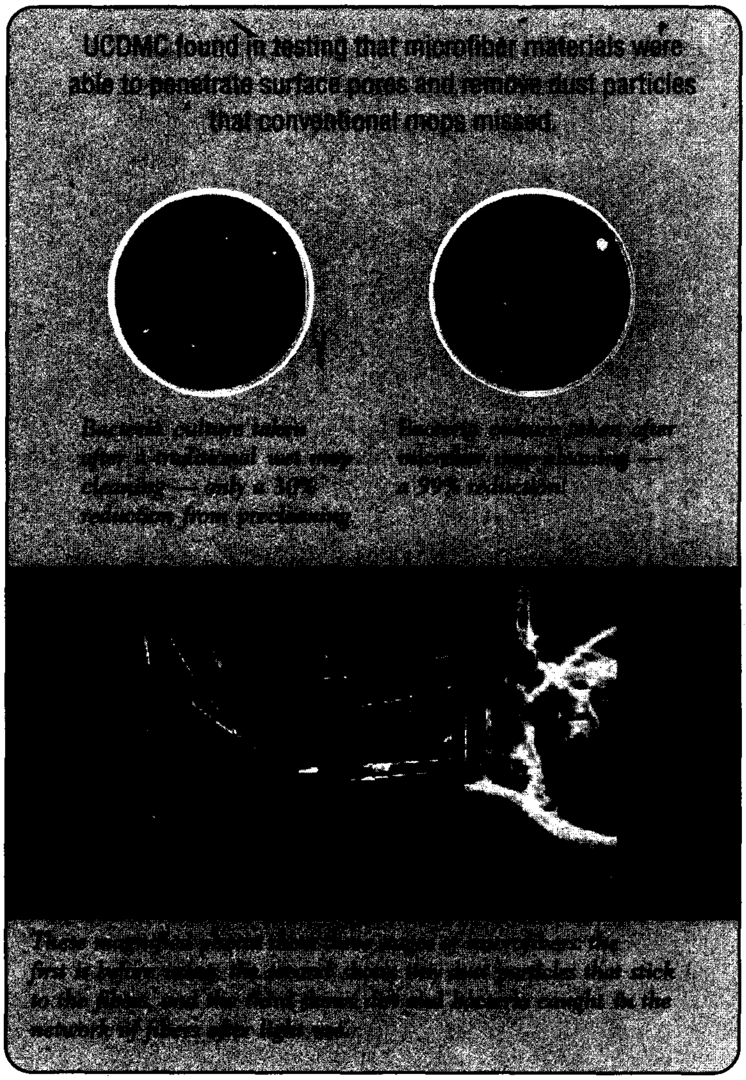
Program Results

UCDMC first used the microfiber mops in a pilot test beginning in summer 1999, and within one year it completely replaced conventional loop mops with the microfiber alternative in all patient care areas. The program resulted in three measurable economic benefits:

- 60% lifetime cost savings for mops
- 95% reduction in chemical costs associated with mopping tasks
- 20% labor savings per day

The initial cost to implement the program was significant, as a microfiber mop costs over three times more than a conventional loop mop. However, the manufacturer guarantees the microfiber mop head for 500 washings, while a conventional mop typically withstands only 55 washings, giving the microfiber mop a comparatively low lifetime cost. Although UCDMC uses quaternary ammonium chloride solution for other applications, switching to the microfiber mopping system reduced the amount of the chemical purchased by 46 percent, from 513 gallons in 1999 to 283 gallons in 2000. Also, because the microfiber mops are easier and faster to use, UCDMC saved 638 hours per year for each worker, or approximately $7,665 in wages.

Three other economic benefits are less easily quantified and will vary by location: 1) cost savings from decreased water use, 2) reduced workers' compensation claims, and 3) potential construction savings from eliminated need for mop sinks in janitor's closets. Because janitors no longer change cleaning solution every third room, UCDMC cut its water use for mopping by 95%. Another benefit that has become apparent is the cost savings from reduced workers' compensation claims. UCDMC management has determined that the microfiber mops are easy enough to use that janitors placed on "light duty" because of an injury are tasked with mopping floors. However, because of the variety of claims made and the inconsistent associated costs, UCDMC has been unable to quantify the cost savings from reduced claims. Lastly, since microfiber mops eliminate the need to frequently change cleaning solution and rinse mop heads, the need for a mop sink in janitor's closets is eliminated. This should be taken into consideration when new facilities are built or existing facilities are remodeled.



Limitations

UCDMC does not use the microfiber mops in areas contaminated with an extraordinary amount of blood or other body fluid, including certain areas of the emergency and operating rooms. In these cases, UCDMC personnel use conventional loop mops. The microfiber mops are also not used in greasy, high-traffic kitchen areas; rather, UCDMC continues to use mechanical floor cleaning machines in these areas.

The microfiber mop heads cannot be laundered in industrial washers and dryers, as the heat settings are often too high and can damage the material. To address this issue, UCDMC established a cooperative agreement with Mercy General Hospital (which also uses microfiber mops), to launder the mop heads in house. Mercy General Hospital uses a standard commercial washer and dryer with controlled heat settings and standard laundry detergent. The vendor advises against using chlorine

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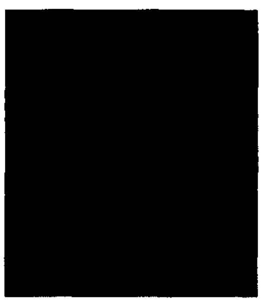

The secret of microfiber

Microfiber cleaning materials are a blend of microscopic polyester and polyamide fibers which are split in such a way as to create microscopic "hooks" which act as claws that scrape up and hold dust, dirt, and grime. They are 1/16 the thickness of a human hair and can hold six times their weight in water.

bleach, which can degrade the material, and discourages washing microfiber mops with other non-microfiber materials.

How many mops do you need?

Because a clean microfiber mop head must be used in each patient room, UCDMC learned that it is important to consider the amount of time required to launder the mop heads when determining how many to purchase. If this factor is not properly evaluated, instances could occur where not enough clean microfiber mop heads are available for the day's cleaning routine. Simply put, the longer the turnaround time for laundering the mop heads, the more mop heads needed. UCDMC learned that room size affects the number of mop heads needed. Because a microfiber mop is not dipped back in the cleaning solution once the mop has been used, larger rooms may require more than one mop head. Mercy General Hospital has implemented another way to add more moisture and cleaning solution without causing cross-contamination concerns: their janitorial staff carries a spray bottle of cleaning solution to use on stubborn spots or to provide additional moisture.

Resources

UCDMC Case Study:

Environmental
Service Department
(916) 734-3425

Vendors:

Clean System
(415) 939-0301
www.cleansystem.com

Edge Tech Industries
(858) 627-9260
www.edgetk.com

Redco
(714) 418-2960
www.dustneversleeps.com

The-Cloth.com
(877) 837-3045
www.amazingcloth.com

The Rag Company
(208) 322-4703
www.theragcompany.com

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Reducing Ethylene Oxide and Glutaraldehyde Use

Environmental Best Practices for Health Care Facilities | November 2002

JCAHO Environment of Care Standards 1.3, 2.3, 4.0

Where are Ethylene Oxide and Glutaraldehyde Used?

Although many environmentally preferable technologies exist for sterilizing equipment and surfaces within hospitals, these technologies can damage some medical instruments that are susceptible to moisture and heat. In such cases, hospitals typically use ethylene oxide (EtO) to sterilize moisture- and heat-sensitive instruments and glutaraldehyde as a high-level disinfectant. Health care employees who commonly use glutaraldehyde-based products work in many departments, from gastroenterology, urology, and cardiology to x-ray, laboratory, and pharmacy. This fact sheet provides background information on the uses and hazards of both chemicals, describes environmentally preferable alternatives, and provides detailed case study and cost information to help your hospital evaluate alternatives to EtO and glutaraldehyde.

The first step in assessing the impacts of EtO and glutaraldehyde is to conduct an inventory of who, how, and where the chemicals are used in your hospital. Completing the usage inventory will enable you to prioritize your actions, monitor progress in eliminating the use of the chemicals, and ensure that affected employees are included in training and monitoring programs. In addition, an inventory may create opportunities for gathering feedback from hospital personnel on EtO, glutaraldehyde, and which alternatives might be best. Common locations to look for EtO and glutaraldehyde are mentioned in the following sections.

Why Eliminate EtO?

Ethylene oxide (EtO) poses several health hazards requiring special handling and disposal of the chemical and training in its use. It is identified by the National Toxicology Program as a known human carcinogen (see http://ntp-server.niehs.nih.gov/) and has several other acute and chronic health effects:

- Inhaling EtO can cause nausea, vomiting, and neurological disorders.
- In solution, EtO can severely irritate and burn the skin, eyes, and lungs.
- EtO is a probable teratogen and may pose reproductive hazards.
- EtO may damage the central nervous system, liver, and kidneys, or cause cataracts.

EtO is also extremely reactive and flammable, increasing the risk of chemical accidents that could injure hospital employees and patients. For example, even static electricity can cause EtO to ignite; therefore, employees using it should be well trained and aware of its potential dangers. A small selection of hydrogen peroxide- and peracetic acid-based sterilants can be used to replace EtO for many applications throughout your hospital. The following case study discusses the costs and benefits of switching to non-EtO alternatives.

MHMHs 3-Step Approach to Eliminating EtO

1 *Determine which medical instruments are sterilized using EtO.*

2 *Evaluate methods of eliminating EtO steriliza-tion for each instrument.**

3 *Establish a "working group" to facilitate the decision making process and ensure that sterilization standards are not compromised.*

*Usually achieved by alternative technologiesor a new or alternative device approved for sterilization with non-EtO technologies

case study | Finding Alternatives to EtO at Mary Hitchcock Memorial Hospital[1]

Facing increasing regulatory pressure and a growing awareness of the occupational exposure hazard of using EtO, Mary Hitchcock Memorial Hospital (MHMH) in Lebanon, New Hampshire began evaluating non-EtO sterilization unit alternatives. MHMH adopted two alternative technologies: Sterrad, a plasma phase hydrogen peroxide-based sterilizing agent and Steris, a peracetic acid-based technology. The primary difference between the two alternatives is that Steris is a "just-in-time" technology that requires sterilized items to be immediately used after being removed from the unit. This aspect makes it impractical in some applications, specifically for trauma cases where the need for a specific instrument cannot be predetermined. In most cases,

continues

MHMH Sterilization Cost Comparison

Ethylene Oxide (EtO)		Non-EtO Alternatives	
Capital Costs			
New emissions control equipment for existing EtO unit	$25,000	2 Sterrad units	$212,000
Renovation and construction	$20,000	2 Steris units	$35,000
"Lost time" from construction disruption	$20,000	New and/or replacement of instruments over 2 yrs	$50,000–$75,000
2 Sterrad units[2]	$212,000	Cost Total:	$297,000–$322,000
Cost Total:	$277,000		
Annual Operating Costs[3]			
Emissions control	$10,000	Sterrad operating costs	$2,000
Spill response and staff training	$5,000	Steris operating costs	$1,000
Alarm system maintenance, testing, EtO monitoring	$5,000	EtO outsourcing ($80/load, approx. 60 loads/year)	$4,800
Sterrad operating costs	$2,000	Cost Total:	$7,800
Cost Total:	$22,000		

[1] Background information adopted from Tellus Institutes "Healthy Hospitals: Environmental Improvements Through Environmental Accounting—Appendix B"
[2] Because EtO operations are limited to one load per day under MHMHs Title V permit, the addition of two non-EtO units were needed to meet the sterilization needs of the hospital.
[3] Contingent costs of an EtO incident or related fines are not included

Sterrad has proved to be an acceptable alternative to EtO; however, in some instances, manufacturers have not yet approved the use of EtO alternatives for sterilization of their products. Such limitations vary by vendor and are not specific to one instrument or medical device product type. For example, MHMH must still sterilize the following five instruments using EtO: angioscopes, choledocoscopes, surgiscopes, bone flaps, and hysterectoscopes.

Devices that have not been approved for sterilization using EtO alternatives are often constructed of complex mixed-media materials. To completely eliminate the need for EtO, MHMH is collecting data from other healthcare facilities to find alternative instruments (or in some cases, the same product by a different vendor) that have been approved for non-EtO sterilization alternatives.

Advanced Sterilization Products provided the following costs per sterilized square foot:

MHMH conducted a detailed cost analysis to evaluate the difference between using EtO and non-EtO sterilization technologies (see "MHMH Sterilization Cost Comparison"); however, several costs and benefits of eliminating EtO were not quantified, including:

- Transaction cost of reduction effort
- Value of quicker average sterilization time
- Benefit of increased availability of instruments and sterilization process control, which ultimately translates to better infection control
- Instrument upgrade/replacement costs; some of which would have been necessary regardless of the EtO elimination effort
- Benefit of avoided EtO exposure incidents

Overall, MHMH staff are pleased with both Steris and Sterrad technologies. In addition, because the new technologies have shorter processing times and therefore higher productivity, MHMH is able to sterilize instruments that were previously being high-level disinfected. Also, the labor required to operate the technologies has proven to be less than expected, despite increased productivity.

Why Eliminate Glutaraldehyde?

Glutaraldehyde is most frequently used as a cold liquid high-level disinfectant for heat-sensitive equipment such as dialysis instruments; surgical instruments; suction bottles; bronchoscopes; endoscopes; and ear, nose, and throat instruments. There are other, less obvious areas where glutaraldehyde is used as well. For example, it is used as a tissue fixative in histology and pathology laboratories and as a hardening agent in the development of x-rays. Unlike EtO, glutaraldehyde is not a human carcinogen; however, several health effects have been reported among hospital workers exposed to glutaraldehyde:

- Asthma, and breathing difficulties
- Burning eyes and conjunctivitis
- Headaches
- Nosebleed, irritation, sneezing, and wheezing.
- Hives
- Nausea
- Rashes and allergic dermatitis
- Staining of the hands
- Throat and lung irritation

Several hydrogen peroxide-, peracetic acid-, and orthopalahaldehyde-based high-level disinfectant solutions can be used to replace glutaraldehyde throughout your hospital. The following case study discusses the costs and benefits of switching to glutaraldehyde alternatives.

case study | Kaiser Woodland Hills Medical Center Eliminates Glutaraldehyde

Prompted by increasing health concerns related to the use of glutaraldehyde, Kaiser Woodland Hills Medical Center

(Woodland Hills) in Woodland Hills, CA eliminated it from its highest use area: the Gastroenterology Department. This department accounts for over 50% of the hospital's glutaraldehyde use. The department relies on eight automated endoscope reprocessors for high-level disinfection of endoscopes, which are in use about eight hours each day. The Environmental Health and Safety Director at Woodland Hills identified Cidex OPA (ortho-phthalaldehyde) as a possible glutaraldehyde alternative because of 1) its lower inhalation exposure risk, 2) reduced disinfecting time (12 minutes vs. APIC-approved 20 minute disinfection time and FDA-approved 45 minute disinfecting time for Cidex), 3) the solution is approved for use in almost all of their equipment without negating the warranty and 4) the cost of using Cidex OPA was significantly less than installing a more substantial ventilation system to minimize respiratory irritation from using glutaraldehyde. Cidex OPA, however, cost approximately $25 per gallon– three times more than glutaraldehyde.

Due to its toxicity, California legislation deemed Cidex OPA a hazardous waste beginning January 1, 2001. However, this legislation exempts healthcare facilities from tiered permitting regulatory requirements when treating Cidex OPA with glycine on site to render it a non hazardous waste. (If local publicly owned treatment works (POTWs) or sewer agencies have other prohibitions against sewerage of aldehydes, facilities must seek approval for this process as well.) To comply with California legislation, Woodland Hills treats Cidex OPA with 25 grams of glycine per gallon for 1-hour, which renders it a non-hazardous waste. Woodland Hills must utilize an external treatment tank for this process, since manufacturer warranties would be voided if the Cidex OPA were treated within the reprocessor. It spent

continues

Top Reasons to Eliminate Glutaraldehyde
Adapted from the Sustainable Hospitals Project

- *Glutaraldehyde is a potent occupational skin irritant and sensitizer.*
- *Glutaraldehyde is a recognized cause of occupational asthma.*
- *Patients, visitors, and hospital employees may be needlessly exposed to glutaraldehyde vapors in patient rooms and clinic areas where open bins or poorly ventilated reprocessing units are in use.*
- *Cost-competitive alternatives exist that meet infection control standards and reduce risks to patient, visitor, and employee health.*
- *Several regulatory organizations, including OSHA, NIOSH, and ACGIH, are re-evaluating their exposure limits for glutaraldehyde.*

The Sustainable Hospitals Project website includes a 4-step glutaraldehyde use survey that can help 1) identify *where glutaraldehyde is used, 2)* prioritize *areas for improvement, 3)* monitor *progress, and 4)* ensure *affected employees are included in training and monitoring programs.*

Overview of EtO and Glutaraldehyde Alternatives

Product (Vendor)	Application	Cost	Comments
EtO Alternatives			
Sterrad (Advanced Sterilization Products)	Enclosed sterilization processor with 45-minutecycle time	Processor $65,000 to $130,000 Hydrogenperoxide cassettes $216 to $265 per case ($43 to $53 per cassette, or $9 to $10 per cycle)	Generates hydrogen peroxide gas plasma from 58% hydrogen peroxide solution
Steris 20 (Steris Corporation)	Sterilizationin 12 minutes at 50 to 55°C; instruments "patientready" in less than 30 minutes	Processor $18,200 Peracetic acid cups $128 per case ($7 per cup)	0.2% peracetic acid (diluted from 35%)
Glutaraldehyde Alternatives			
Cidex OPA (Advanced Sterilization Products)	High-level disinfection in 12 minutes at 20 °C	$25 per gallon	0.55% OPA solution: exposure limits not yet determined
Sporox II (Sultan Chemists)	High-level disinfection in 30 minutesat 20 °C	$25 per gallon	7.5% hydrogen peroxide
Sterilox (Sterilox Technologies Inc.)	Cycle time is 10 minutesfor high-level disinfection	Rental of generator $15,000 year costing approximately $1–$3 per cycle, depending on use	System generates hypo-chlorus acid Currently used in Europe as liquid chemical sterilant; FDA pre-market clearance pending

Table adapted from Sustainable Hospitals Project website. Costs provided are vendor list prices; actual costs may vary significantly under contract agreements.

$700 to purchase the external treatment tank, which includes a mobile cart, treatment tank, pump, and tubing. Glycine costs approximately $5 per gallon, including the cost of the product and labor. This is more effort than what is required for glutaraldehyde; vendors often provide test strips that when dipped in solution, will change color to show whether it has fully degraded.

Despite the added treatment steps, Woodland Hills employees are very satisfied with the OPA-based product. Symptoms associated with using Cidex OPA are described as being very mild, with select staff indicating slight eyelid irritation and a "chalky" taste after prolonged use. However, Woodland Hills staff noted that the complaints received for OPA are much less frequent and significantly less severe than comments made regarding glutaraldehyde. Also, because Cidex OPA has a quicker cycle time than glutaraldehyde, Woodland Hills saves approximately 8 minutes with each disinfection cycle, or a savings of 1 hour for each 8-hour automated endoscope reprocessor shift. This allows greater turn-over of endoscopes, while requiring fewer reprocessors to disinfect them. This is especially important to consider for new facilities, since the cost of endoscopes is approximately $30,000 and reprocessors are often near $15,000. In addition, Woodland Hills has found that Cidex OPA does not lose efficacy as fast as the glutaraldehyde-based product. In their high-volume department, they are now able to disinfect approximately 60% more endoscopes during the life of the solution.

Accounting for Time

Perhaps the most significant savings when switching to a non-EtO or non-glutaraldehyde alternative is the value of time saved in sterilizing or disinfecting equipment. This value is difficult to quantify however, because the direct impact of shorter process times is dependent on several factors, including such things as on-hand inventory of equipment and cost of labor.

A Look at Ortho-Phthalaldehyde

(Adapted from the Michigan Health and Hospital Association Employee Safety and Disability Service Newsletter)

Also an aldehyde, ortho-phthalaldehyde (OPA) is chemically related to glutaraldehyde. According to the Michigan Health and Hospital Association (MHA), the disinfecting mechanism of OPA is thought to be similar to glutaraldehyde and is based on the powerful binding of the aldehyde to the outer cell wall of contaminant organisms.

A notable difference between the two commercial disinfectants is the percent of active ingredient in each product. Commercial OPA-based disinfecting products contain only 0.55% of the active ingredient, while most glutaraldehyde-based disinfecting products contain 2.4 to 3.2% active ingredient – 5 to 7 times that of OPA products.

Although OPA may pose similar occupational hazards to glutaraldehyde – including mild eye, skin, and respiratory tract irritation and skin and respiratory sensitization – the risk is significantly reduced due to the low percentage of OPA and relatively low vapor pressure of OPA-based commercial products. OPA does not currently have a recommended exposure limit; however, vendors recommend that similar protective equipment be used, including gloves and goggles.

For example, consider the Kaiser Woodland Hills glutaraldehyde case study: using Cidex OPA saved 1 hour of endoscope processing time each day. This can result in a significant increase in productivity by allowing equipment to be available for patient care sooner. A shorter process time also saves labor, as technicians do not have to wait as long for equipment to process, allowing them to do more with their time. Ultimately, quicker process times can mean that more patients get treated sooner. A careful analysis of how time affects your facility should be performed when considering non-EtO or non-glutaraldehyde alternatives. While difficult to calculate, these savings can easily make up for the higher cost of non-EtO and non-glutaraldehyde alternatives.

Resources

Cidex OPA Material Safety Data Sheet, Advanced Sterilization Products. http://www.cidex.com/ASPnew.htm

Massachusetts Toxics Use Reduction Institute. "Massachusetts Chemical Fact Sheet: Ethylene Oxide." www.turi.org/PDF/eo.pdf

Michigan Health and Hospital Association. "Glutaraldehyde Free High Level Disinfectant Introduced," March 2000. www.mhaservicecorp.com/esdm/newsletter_archive/pages_archive/Years_past/March2000nv.html

National Institute for Occupational Safety and Health. "Glutaraldehyde: Occupational Hazards in Hospitals." May 2001.

National Safety Council. "Ethylene Oxide Chemical Backgrounder." July 1997. www.nsc.org/library/chemical/EthylenO.htm

Occupational Safety and Health Administration. www.osha-slc.gov/SL TC/ethyleneoxide/index.html

Sustainable Hospitals Project. www.sustainablehospitals.org

Tellus Institute. "Healthy Hospitals: Environmental Improvements Through Environmental Accounting." July 2000. www.tellus.org/b&s/publications/R2-213-Nb.pdf

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Environmental Best Practices for Health Care Facilities | November 2002

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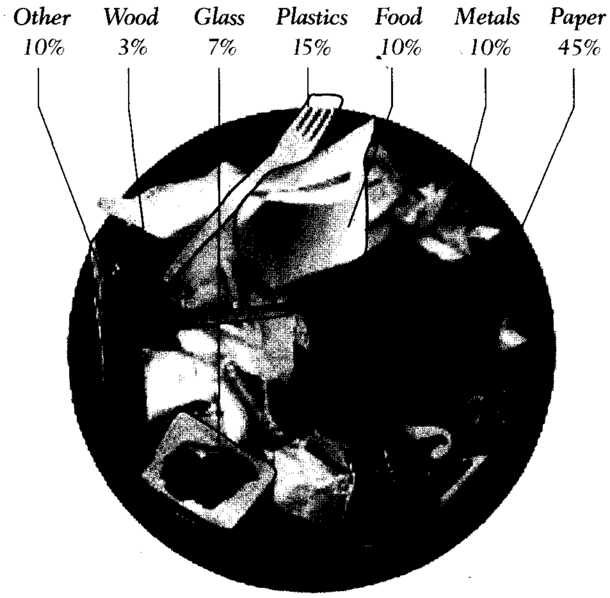
Standards 1.3, 2.3, 4.0

How Much Waste is Wasteful?

Although medical and infectious wastes are often highlighted in evaluations of a hospital s waste stream, these hazardous wastes constitute only 15% of a hospital s total waste generation. The remaining 85% of a hospital s waste, which is considered to be nonhazardous solid waste, is similar to a combination of wastes from hotels, restaurants, and other institutions providing lodging, food services, data processing and administration, and facility operations. In fact, disposal costs for hospital solid waste in 2000 ranged from $44 to $68 per ton, depending on local conditions, disposal method (landfilling versus incineration), and proximity to the disposal facility. Often, solid waste is mistakenly placed in red bag or medical waste containers, thus increasing the cost of disposal and unnecessarily raising the level of treatment needed for the waste. By implementing effective solid waste reduction and recycling programs, hospitals can significantly reduce their solid waste streams.

This fact sheet highlights case studies for three of the largest components of an average hospital s solid waste stream: paper material (including cardboard), plastics, and food waste. The case studies provide detailed information on costs, savings, and implementation issues to help your facility evaluate these waste reduction and recycling techniques.

Hospital Solid Waste Composition



From Bisson, McRae, and Shaner, 1993

Reusable Totes: Cardboard Pollution Solution

Cardboard and other paper materials represent almost half of a typical hospital s solid waste stream. The following case study describes how one large healthcare system decreased cardboard and packing material use by implementing reusable totes for internal distribution of supplies. The cost-effectiveness of using reusable totes varies among hospitals and greatly depends on the structure of the health care organization. The reusable totes are most cost-effective when they replace a constant cardboard need, such as when a health care system has a central distribution center and uses new cardboard boxes to distribute materials to satellite locations. However, the scale of a reusable tote program can be tailored to meet the needs of the organization —even on a small scale, reusable totes may be a cost-effective alternative for replacing a constant cardboard need.

case study | Cutting Cardboard with Kaiser Permanente

Kaiser Permanente (Kaiser) operates three distribution facilities that serve as central supply warehouses for all its hospitals and clinics throughout the United States. Kaiser sorts and repackages the medical supplies delivered to the central supply facilities (most often on pallets) based on the needs of each hospital and clinic. In 1990, Kaiser implemented a pilot program that has since changed the way it manages inventory: Kaiser began using reusable totes in place of disposable cardboard boxes for distribution.

The program began in Kaiser's Livermore, California, supply warehouse, which serves 12 northern California hospitals. Initially, Kaiser purchased a total of 11,000 totes in four sizes: large, medium, small, and tiny. This enabled warehouse employees to select totes based on the volume of material to be distributed, nearly eliminating the packing material needed to fill partially full containers. Since implementing the program in 1990, Kaiser has saved approximately $40,000 a year by dramatically reducing the cardboard boxes, tape, and filler purchased. Because Kaiser had previously recycled the cardboard at no cost, most of it was

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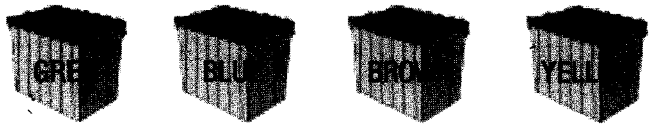
already being diverted from the landfill and does not represent a significant savings in avoided disposal costs. Unlike cardboard boxes, the totes do not require assembly for use and resulted in a significant increase in productivity, saving approximately 500 labor hours or $12,100 in wages annually.[1]

Kaiser also reduced the amount of labor required for delivery of supplies to end-users by color-coding the totes according to their content. Kaiser employees can identify the contents—and general destination – simply by noting the color of the tote.

Because the large, medium, and small totes each have the same footprint, they are easily stackable ("nestable") and do not require much storage space – the medium and large totes have an average footprint of 15 by 21 inches, varying in height between 6 and 9 inches. The smaller totes are 6 inches high and have a footprint of 10 by 10 inches.

In addition, the totes have proven to be very durable. Since the initial purchase, Kaiser has bought an additional 500 to 700 totes per year (5 to 7% of total inventory) to replace totes that were damaged, "lost" in the system (used for storage), or stolen.

Kaisers color coded totes helped reduce labor cost and simplify routing



For non-perishable consumable goods such as intravenous bags, tubing, and bandages

For pharmacy refills that are less time-critical

For initial prescriptions that are urgently needed

For refrigerated medication that must be kept cold

Lastly, the totes have not posed a significant maintenance issue. Because the contents of the totes are new, sealed products, the interiors of the totes stay clean. About every other year, Kaiser sends 25 percent of the inventory to be steam-cleaned, which costs $0.50 per tote or $687.50 annually.

The program has since been expanded from the Livermore facility to the other two central supply warehouses.

Kaiser Permanente Reusable Tote Program

Before		After	
Cardboard Boxes (360,000), Tape, and Packing Material	$40,000	Purchase of 11,000 Totes at $14.50 each[3]	$159,500
500 Hours for Box Assembly[2]	$12,100	Steam-Cleaning 25% of Tote Inventory[4]	$688
Disposal of Cardboard Boxes	Not quantified[5]	Replacing 500 to 700 Totes	$8,700

Payback Period: Less Than 4 Years

[1] While not quantified for this case study, additional labor may have been saved since Kaiser did not have to breakdown the cardboard boxes for recycling.
[2] Exact numbers were not available at the time of this fact sheet publication. Kaiser estimates that a cardboard could be assembled in 5 seconds or 720 cardboard boxes per hour.
[3] The average retail cost for a 12-gallon tote sold by vendors listed on the back page of this fact sheets; considerable discounts are typically offered to organizations purchasing in bulk.
[4] Totes are steam-cleaned every other year costing Kaiser $687.50 annually
[5] Since the cardboard was recycled at the facility where the supllies were delivered, cumulative disposal costs were not available.

Blue Sterile Wrap and Plastic Film Recycling

Recently, blue sterile wrap recycling has attracted interest as a way to significantly reduce the amount of plastic disposed as solid waste. For example, the Nightingale Institute estimated that approximately 19% of the waste stream generated by surgical services is blue sterile wrap. Made of polypropylene (plastic #5), a polymer with good resistance to chemicals and wear, blue sterile wrap is used in all hospitals to protect patient gowns and toiletries, medical devices, and surgical instruments from contamination. Blue sterile wrap waste is most often generated in just a few areas of a hospital, simplifying the collection process. Blue sterile wrap is not reusable, as the material does not withstand the sterilization process between uses. Less bulky material has been considered; however, the alternatives have not matched polypropylenes ability to 1) resist tearing when holding sharp surgical instruments and 2) provide a protective moisture barrier to prevent contamination after sterilization. Recently, several manufacturers have begun using polypropylene as feedstock for other retail products, making it easier to recycle blue sterile wrap and other plastic films (including plastics #2, #4 and #5). Nonetheless, a few key requirements must be met to make a recycling program practical:

- Identify a local market for polypropylene or #5 plastics. Without a regional recycler, it is unlikely that a program will be economically feasible. It is inefficient to ship the material significant distances for recycling because of the relatively low market value of #5 plastics and the high volume and low weight of the material.

- Establish a low-cost collection and transport system. Because the market value of polypropylene is relatively low, collection and transportation costs must be minimized. Essentially, the cost of collection and transport cannot exceed the recycling income (approximately $0.04 per pound) and avoided disposal fees (approximately $0.03 per pound, or $56 per ton).
- Generate a significant quantity to warrant vendor cooperation. Although arrangements can be made with local recyclers to supply blue sterile wrap and plastic film collection containers at little or no cost to a hospital, the facility must generate enough used polypropylene to make the program worthwhile. However, the quantity required varies directly with regard to the points above. For example, the further the distance from a regional recycler, the greater the quantity required to support a program.

These requirements are dependent on other factors as well, such as distance to a regional recycler and proximity to other healthcare facilities that are also recycling blue wrap and other plastic films. The following case studies provide details of how two organizations have implemented successful blue sterile wrap recycling programs and highlight the potential environmental and economic benefits. The first case study highlights a new program, while the second features a program that has been operating for over 10 years.

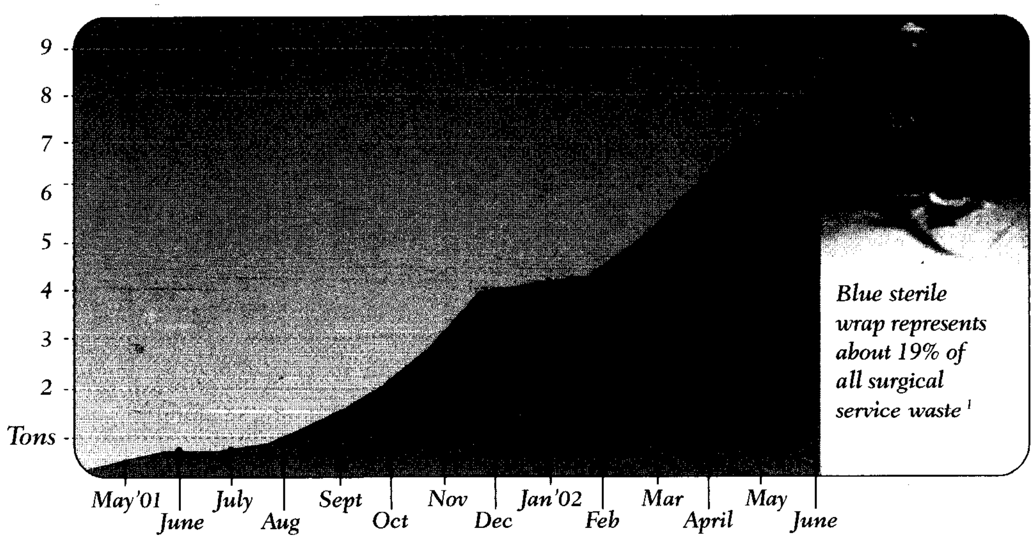
Dominicans Blue Sterile Wrap Program Performance

Recycling Total: 8 tons in 12 months
Per Month Average: 1,300 lbs per month
Total Diversion Savings: $544

case study | Easy Transition to Recycle Blue Sterile Wrap and Plastic Film

Dominican Hospital (Catholic Healthcare West) in Santa Cruz, California, implemented a blue sterile wrap and plastic film recycling program in May 2001. Dominican's initial objective was to divert only the blue sterile wrap from the waste stream; however, the hospital learned that their plastic film often used to package materials and wrap pallets can also be recycled with the blue sterile wrap. Clearly labeled collection containers were placed in the six departments that generated the highest quantities of blue sterile wrap and plastic film waste: central distribution, purchasing, the pharmacy, the operating rooms, outpatient oncology, and labor and delivery. Before implementing the program, the environmental staff discussed program objectives and logistics with department staff members – including nurses, administrative personnel, and custodial employees – to address their concerns and convey the benefits of the program. In total, Dominican's environmental staff spent about 3 days setting up the program, including gaining buy-in from hospital staff, working with vendors, and setting up collection containers and schedules.

Dominican Hospital
Cumulative Blue Sterile Wrap and Plastic Film Recycling
May, 2001 through June, 2002



Collection Containers and Disinfection

One concern that emerged from the meetings with department staff was how to disinfect the containers used to collect the blue sterile wrap and plastic film. Although administrative departments such as central distribution and purchasing were satisfied with the standard cardboard containers, the operating room wanted containers that could easily be routinely disinfected. Therefore, a stainless-steel frame that could be easily wiped down was used to collect blue wrap in individual operating rooms.

Material Management

The custodial staff spends less than 30 minutes each week emptying all the collection containers in the hospital as they are filled. Full bags, weighing about 17 pounds each, are transferred to a 3-cubic-foot dumpster on the building's loading dock. Dominican donates the sorted blue sterile wrap and plastic film to a local nonprofit recycling organization, Grey Bears, that uses the proceeds from the sale of recyclable commodities to buy and prepare hot meals for disadvantaged senior citi-

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zens in the community. Grey Bears picks up the dumpster each Friday and bales the blue sterile wrap and plastic film until a full-enough load has accumulated to warrant a pickup by Marathon Recovery of Oakland, California, which purchases the material to be used as a binding agent in making siding materials.

A similar program was established throughout the Legacy Health System (LHS) in Portland, Oregon. Since summer 1991, housekeeping employees collect sorted recyclable commodities, including blue sterile wrap and other polypropylene plastics, at four LHS hospitals in the greater Portland area. The material is collected in either clear or blue plastic bags and is delivered to the recycling depot in each building.

Legacy Health System Blue Sterile Wrap Recycling Program

Monthly Diversion Savings:
$400

LHS owns and operates its own recycling center just two blocks from Good Samaritan Hospital, one of LHS's facilities. LHS has established a cooperative relationship with several of its vendors, including Kimberly-Clark, Owens and Minor, and BioMed, to transport the recyclable commodities to the LHS recycling center. The commodities are hauled as "backfill" material, meaning that they are collected on return trips when the vendors' trucks are empty. In addition to the four LHS hospitals, LHS has begun accepting blue sterile wrap waste from other Portland-area hospitals that can make similar transport arrangements with their vendors.

Blue sterile wrap recycling at Dominican Hospital

Once the recyclable commodities are dropped off at the recycling center, employees of the Susan Christiance Vocational Program (SCVP), a non-profit organization that employs challenged individuals, sort the material. The blue sterile wrap is placed in a 40 cubic-yard roll-off container provided at no cost by Waste Management Incorporated. The container is hauled three to four times per month, diverting 3.5 tons of blue sterile wrap from the solid waste stream and saving $400 in disposal costs. Waste Management bales the blue sterile wrap and, once enough has accumulated, transports the material to Marathon Recovery.

Getting Green in the Kitchen

The kitchen and food service operations of a hospital leave a unique mark in the hospitals environmental footprint. Although food waste itself can represent 10% of the hospitals waste stream, for every patient tray, another 15 pounds of waste is generated (including glass, cans, and cardboard from food and washing solution packaging).[2] Although the kitchen and food service operations of a hospital generate a variety of solid wastes, source reduction and recycling programs often overlook this area of the facility—especially the opportunity to divert organic matter through composting food waste. However, there are several obstacles to consider when implementing a food waste composting program:

Space limitations. In many cases, space constraints are the primary factor dictating which composting method a hospital can adopt. Because hospitals are often located in urban areas where space is limited, they must either make arrangements to haul the food waste to an off-site composting facility or purchase a compact, in-vessel composting unit.

Beating the stigma. The benefits of composting are often misunderstood and overshadowed by misconceptions. For example, many people fear that composting will produce a strong odor and attract pests such as insects or rats. Consequently, a composting program should feature (1) management buy-in to ensure that employees participate in the program and (2) well-run operations to prevent odor and the presence of pests.

Program participation. For composting to be cost-effective, a hospital must tailor the scale of the program to the quantity of food waste generated and must ensure that employees participate in the program. Both points are especially important for facilities that make a significant capital investment in purchasing on-site composting technologies.

Vermitech system (worms, digester and shredder):
$25,000

Building and supplies:
$31,000

Labor:
$62 per week

Composting Program Costs VS. Savings

Diversion savings:
$59.50 per ton

Worm castings:
$1 per pound

[1] Medcycle Offers Opportunities for Nurses as Front-Line Recyclers, Nightengale Institute, www.nihe.org/medcyc.html
[2] Saving Disposal Dollars: Hospital Finds Winning Waste Reduction Formula BioCycle, January 1999

The following case study provides details of how one facility has begun to divert food waste from their cafeteria and discusses some of the obstacles to implementing a successful program.

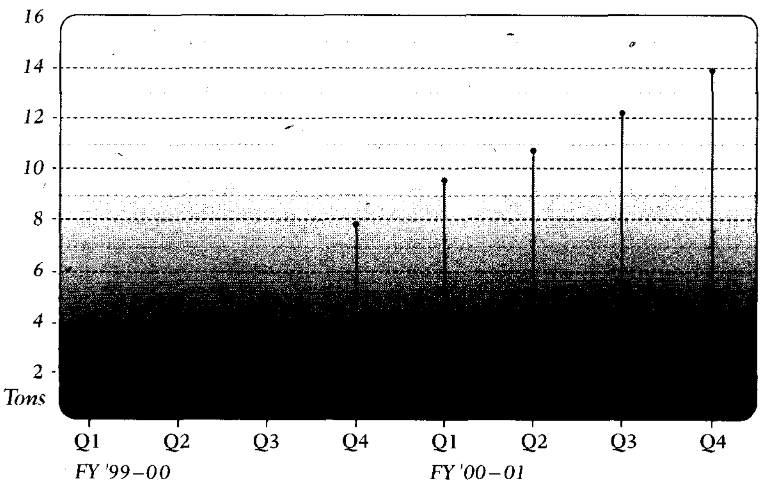
case study | Putting Worms to Work at the Medical University of South Carolina

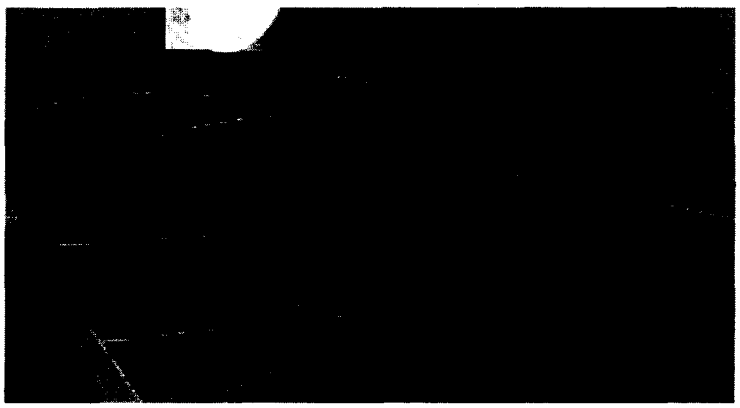
In a continuing effort to cut material from its waste stream and noting the success of other universities' composting programs, the Medical University of South Carolina (MUSC) in Charleston, South Carolina, implemented a food waste composting program in July 1999. Three state and national organizations provided approximately 70 percent of the startup costs: the Department of Health and Environmental Control (DHEC), the DHEC Energy Office, and the Sustainable Universities Initiative. Because of its urban location and significant space contraints, MUSC chose to install the Vermitech Systems Incorporated in-vessel vermi-organic digester.

MUSC built a simple, 18 by 24-foot building to house the digester; building features include a sloped floor coated with acrylic for easy cleanup, a ventilation fan, and a 10-gallon water heater. (The digester can also be placed in an existing structure or in a secure outdoor location.) Necessary supplies include four 45-gallon, wheeled containers; a scale; a long-handled squeegee; gloves; a long-handled plastic broom; a flat headed-shovel; a hose with multi-option spray nozzle; a dustpan; and pH and moisture meters.

Contracted kitchen staff collect preconsumer food waste from the hospital's cafeteria kitchen in a 45-gallon container. Once a day the recyling staff collects the container, which varies in weight according to its contents. The contents are fed into a

Medical University of South Carolina
Composting Food Waste Diversion Amounts
1999 through 2001





Thousands of worms live in the Vermitech Systems composting digester at MUSC, turning food waste into a valuable soil amendment.

shredder, where the food waste is mixed with cardboard until the appropriate moisture level is obtained. The mixture is then fed into the in-vessel digester by a conveyer belt. The worms in the digester can eat 250 pounds per day, reducing the volume of the food waste and cardboard mixture by 80 percent overnight. The worms produce castings that are used as a soil amendment and have a value of about $1 per pound. The castings also slightly reduced the hospital's need for commercial fertilizers and actually improved the condition of the soil. Because the worms tend to stay near the top of the in-vessel digester (near the fresh food), the castings are mechanically harvested from the bottom of the container. The castings fall to the floor, where they are swept up using a broom and squeegee. The castings are then given to MUSC's grounds department. It typically takes no more than 1 hour each day to collect the food from the cafeteria and transport it to the composting building, process the food through the digester, and clean up after processing a batch of food waste. The recycling coordinator also spends 30 minutes per week checking the depth of the digester bedding and the health of the worms and their environment.

MUSC composts 115 pounds of food waste each day, representing 50 percent of the digester's operating capacity. At this rate, the program can sustain itself, but is not paying back the capital costs required to set up the program. MUSC believes that the low participation rate is due to ongoing employee resistance and skepticism. Although the MUSC recycling staff makes constant efforts to convey the benefits of the program and encourages MUSC kitchen staff to participate in the program, staff participation level ranges result in using only 30 to 70 percent of the digester capacity. If the program operated at 100 percent capacity, processing 250 pounds of food waste per day and harvesting 3,000 pounds of castings per month, the payback time would be approximately 6 years (which is comparable to other in-vessel unit payback periods).

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Resources

Reusable Totes

Kaiser Permanente
(818) 321-2276

Akro-Mils
(800) 253-2467

Remcon Plastics Inc.
(800) 253-2467

Blue Sterile Wrap and Plastic Film Recycling

Dominican Hospital
(831) 462-7674

Legacy Health System
(503) 413-6066

Conigliaro Recycling
(888) 266-4425

Marathon Recovery
(510) 636-4191

Composting

Medical University of South Carolina
(843) 792-4066

Green Mountain Technologies
(802) 368-7291

Vermitech Systems Inc.
(416) 693-1027

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