A New Era:
The Elimination of Mercury Sphygmomanometers

Mercury Pollution and the Health Care Industry

Mercury is a naturally occurring heavy metal that is linked to numerous health effects in wildlife and humans. At ambient temperature and pressure, mercury is a silvery-white liquid, though it can readily vaporize and may stay in the atmosphere for up to a year. When released to the air, mercury is moved by global transport processes and deposited globally. Mercury ultimately accumulates in lake bottom sediments, where it is transformed into a more toxic form, methyl mercury, which builds up in fish tissue.

Fish consumption advisories due to mercury contamination are in place on thousands of water bodies across North America and all five Great Lakes. Forty-four states have issued advisories on all or parts of their waterways. Individuals with high methyl mercury exposures from frequent fish consumption might have levels of mercury in their bodies that impact thier health. The population at highest risk is the children of women who consume large amounts of fish and seafood during pregnancy.

Mercury is neurotoxic and can damage the central nervous system. Mercury exposure can cause tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during fetal development, and attention deficit and developmental delays during childhood.[1] Recent studies suggest that mercury may have no threshold below which adverse effects do not occur. A recent report by the CDC estimated that one in 10 women of childbearing age in the United States is at risk of having a newborn with neurological problems due to in utero mercury exposure.

Health Care's Contribution and Regulation

Through medical waste incineration, health care facilities are recognized as the fourth largest source of mercury to the atmosphere.[2] Hospitals contribute approximately 4-5% of total waste-water mercury[3] (some studies suggest significantly higher loading). In recognition of health care's contribution to the mercury problem, in 1998 the U.S. Environmental Protection Agency and the American Hospital Association signed a voluntary agreement which included the virtual elimination of mercury waste from health care, by the year 2005.

Already the use of mercury thermometers has been restricted and/or banned in many states.[4] There is recognition in the health care profession that other mercury-containing medical devices may soon be phased out through regulation.[5] A variety of state medical associations have adopted resolutions encouraging physicians and hospitals to reduce and eliminate their use of mercury-containing equipment.[6]

Mercury-Free Sphygmomanometers: A Prescription for Human Health

Introduction

Of all mercury instrumentation used in health care, the mass of mercury used in mercury sphygmomanometers (80 to 100g/unit), and their widespread use, collectively make them one of the largest mercury reservoirs in the health care setting. By choosing a mercury-free alternative, a health care institution can have a tremendous impact in reducing the potential for mercury exposure to patients, staff and the environment.

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Accuracy and the Importance of Maintenance

Both mercury and aneroid sphygmomanometers have been in use for about 100 years, and when maintained and calibrated, either gives accurate results.[7] Both devices are required to meet voluntary standards for accuracy set by the Association for the Advancement of Medical Instrumentation (AAMI). Examples of both inaccurate mercury and mercury-free sphygmomanometers can be found in the medical literature,[8, 9] though this inaccuracy is typically related to poor maintenance and calibration. Both mercury and aneroid sphygmomanometers require maintenance and give accurate results when properly calibrated.

A recent study of the Mayo Clinic's aneroid replacement program found that aneroid sphygmomanometers provide accurate pressure measurements when a proper maintenance protocol is followed.[10] In a similar study of the University of Michigan Health System, aneroid devices were found to be accurate.[11] It is important to recognize that no matter what type of blood pressure measurement device is used, it is important to follow the recommendations made by the American Heart Association — that both aneroid and mercury sphygmomanometers must be checked regularly in order to avoid errors in blood pressure measurement, and consequently the diagnosis and treatment of hypertension.[12] Historical concerns about the inaccuracy of mercury-free alternatives, and the belief that the mercury sphygmomanometer is the gold standard are not borne out by the experiences of the multitude of leading institutions that have eliminated their mercury sphygmomanometer units.

Some hospitals that have eliminated mercury sphygmomanometers (1/1/2002)

Hahnemann University Hospital - Philadelphia, PA
Wing Memorial Hospital & Medical Centers - Palmer, MA
Thunder Bay Regional Hospital - Thunder Bay, Ontario
Eastern Maine Medical Center - Bangor, ME
New England Medical Center- Boston, MA
St. Mary's Hospital - Milwaukee, WI
Saint Luke's Hospital - Kansas City, KS
Johns Hopkins Hospital - Baltimore, MD
CLSC Côte des Neiges - Montreal, Québec
Mercy Hospital - Portland, ME
St. Joseph Hospital - Nashua, NH
Massachusetts General Hospital - Boston, MA
Kaiser Permanente - Santa Rosa, CA
St. Mary's Hospital - Duluth, MN
Middlesex Health System - Middletown, CT
St. Mary's General Hospital - Kitchener, Ontario
Northwestern Memorial Hospital - Chicago, IL
Elmhurst Memorial Healthcare - Elmhurst, IL
Dartmouth Hitchcock Medical Center - Lebanon, NH
Mt. Carmel Health Systems - Columbus, OH
St. Francis Medical Center - Hartford, CT
Edith Nourse Rogers Veterans Hospital - Bedford, MA
Dryden Regional Health Centre - Dryden, Ontario
Reid Hospital and Healthcare Services - Richmond, IN
Mid Coast Hospital - Brunswick, ME
Anna Jaques Hospital - Newburyport, MA
The Hospital for Sick Children - Toronto, Ontario
UCLA Medical Center - Los Angeles, CA
Mayo Clinic - Rochester, MN
National Institutes of Health Clinical Center - Bethesda, MD
Cambridge Memorial Hospital - Cambridge, Ontario

Ensuring Proper Calibration

Many healthcare professionals erroneously believe that a mercury sphygmomanometer is a required standard for accurate calibration of any blood pressure device. This commonly held misconception has the potential to negatively impact proper blood pressure determination. Welch Allyn, a US based sphygmomanometer manufacturer addresses this issue in a user manual. "It is important to remember that the ability to measure the accuracy of a sphygmomanometer depends upon the sensitivity of the pressure standard you use for the calibration procedure. If using a manometer (mercury column or aneroid gauge) rated at ±3.0 mm Hg, you will be able to determine the accuracy of the gauge being tested to only ±6.0 mm Hg. If using a device (e.g., digital pressure standard) rated at ±0.1 mm Hg, you will be able to determine the accuracy of the gauge being tested to within ±3.1 mm Hg."[13] A variety of mercury-free calibration equipment traceable to National Institute of Standards and Technology (NIST) is available on the market place (See Digital Pressure Meters). These also have the added benefit of eliminating any potential for mercury spills.

Anecdotal evidence strongly suggests that many facilities do not regularly calibrate their blood pressure equipment. It is important to follow manufacturers recommendations and perform, at a minimum, annual calibration and maintenance of both aneroid and mercury devices.

Mercury-Free Sphygmomanometers: A Financial Imperative

The list of hospitals that have eliminated their use of mercury sphygmomanometers has been growing steadily and includes nationally

recognized institutions such as the Mayo Clinic, the National Institutes of Health's Warren Grant Magnuson Clinical Center, and Johns Hopkins Hospital. The positive experiences shared by these institutions are causing a rapid increase in the number of hospitals beginning to implement mercury replacement programs.

Though many voluntary mercury replacement initiatives have a compelling occupational and environmental health rationale, frequently the biggest motivator for a hospital mercury replacement program is financial. Hazardous waste clean-up costs, reporting requirements for spills, closed patient rooms, and staff training are all extremely expensive. By using non-mercury alternatives, these costs can be eliminated.

In a study done by Kaiser Permanente, the nation's largest not-for-profit Health Maintenance Organization (HMO), it was determined that when associated lifecycle costs are included (compliance, liability, training, etc.) the total cost per unit of an aneroid sphygmomanometer is about 1/3 that of a mercury-containing device. Mercury-containing devices are no longer being procured by Kaiser Permanente.[14]

In many cases the hospital department that incurs these costs operates under a budget that is different from the department that orders the mercury devices. To gain a shared understanding of the financial impacts of mercury use, it is extremely important that the relevant costs are documented and communicated to the departments that order or purchase the mercury devices. Other anecdotes on financial impacts include:

- At Hartford Hospital, mercury spills, mostly from blood pressure equipment, cost the hospital over $60,000 in 1998. As a result of the cost involved in these incidents, Hartford Hospital decided to eliminate the use of mercury blood pressure equipment. The total replacement cost for mercury-free equipment was slightly more than the one-year clean up cost for spilled mercury.
- At the Mayo Clinic, in a two-year time frame between 1993 and 1995, 50 spills were documented related to leakage and spills from sphygmomanometers. Costs associated with these spills were estimated to be $26,000, not including time lost from temporary closure of clinical areas.
- JCAHO, the national health care accreditation body, recently gave a recommendation (citation) to a hospital where staff was insufficiently trained on mercury spill procedures. The hospital decided to eliminate its use of mercury equipment to avoid potential spills and eliminate continual training requirements.

Many vendors of aneroid sphygmomanometers now offer take-back of replaced mercury sphygmomanometers in their aneroid replacement contracts. This service has helped many hospitals avoid hazardous waste removal costs and other management costs associated with mercury, and removed a significant roadblock to sphygmomanometer replacement programs.

Replacing your Mercury Units

Though many hospitals have eliminated their use of mercury blood pressure equipment, replacement has not happened overnight and replacement programs have frequently required a strategic, phased approach. A phased approach is easier to budget and may help solve any transitional hurdles. Remember that documented costs of past spills are a big help in gaining budgetary approval.

Some important considerations when developing your phase-out plan and speaking to vendors:

- Contact other hospitals that have made the switch to get a sense of vendor quality.
- Trial potential products in all departments for feedback.
- Ask if the unit be easily removed from the wall.
- Ask if new units conform to AAMI recommendations.
- Ask if your vendor will assume responsibility for managing the older mercury units and ensure safe and proper handling in their contract agreement.
- Ask if the product carries a lifetime warranty.
- Ask your vendor whether the cuffs are latex and PVC free.
- Ask if the equipment can be recalibrated in the field.*
- Ask your vendor whether all units are individually tested or randomly sampled before shipping.
- Ask your vendor if recalibration is free.

* Remember that if calibration is performed in-house, mercury-free calibration equipment calibrated to National Institute of Standards and Technology (NIST) standards is available in the marketplace.

Other resources:

Sustainable Hospitals Project
Kitson 200
One University Avenue
Lowell, MA 01854
(978) 934-3386
shp@uml.edu
www.sustainablehospitals.org

Health Care Without Harm
1755 S Street NW, Suite 6B
Washington, DC 20009
(202) 234-0091
info@noharm.org
www.noharm.org

Hospitals for a Healthy Environment
1-800-727-4179
h2e@hcwh.org
www.h2e-online.org

Digital Pressure Meters

Setra
159 Swanson Road,
Boxborough, MA 01719-1304
(978) 263-1400
Toll Free (800) 257-3872 www.setra.com

Netech Corporation
60 Bethpage Drive
Hicksville, NY 11801
United States
1-800-547-6557
516-433-7400
www.gonetech.com

Blood Pressure Measurement: Pros and Cons of Alternatives to Mercury Sphygmomanometers

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Notes

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2. USEPA 1997, "Mercury Report to Congress."
3. Personal Communication, Western Lake Superior Sanitary District, Duluth, MN
4. List of state and local ordinances www.noharm.org
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