Mercury is a persistent, bioaccumulative toxin that has been linked to numerous health effects in wildlife and humans. Its natural state under ambient temperature is a silvery-white liquid that changes easily from solid to liquid to gas, allowing it to circulate in the atmosphere and the environment. There are three major forms of mercury that circulate in the atmosphere but the one of most concern for humans and wildlife is methylmercury, because it builds up in the muscle tissue.

Health Effects

Mercury is a potent neurotoxin, which means it attacks the body's central nervous system; it can also harm the brain, kidneys and lungs. It can cross the blood-brain barrier as well as the placenta. Neurotoxic risks to developing fetuses and young children are primary reasons for fish-consumption advisories, aimed at discouraging pregnant women, women of child-bearing age, and young children from eating too much fish. Studies done on women who ate methylmercury-contaminated fish or grain showed that even when the mothers showed few effects of exposure, their infants demonstrated nervous-system damage.

Symptoms of Mercury Poisoning:

* Impairment of the peripheral vision;
* Disturbances in sensations ("pins and needles" feelings, numbness) usually in the hands and feet and sometimes around the mouth;
* Lack of coordination of movements, such as writing;
* Impairment of speech, hearing, walking;
* Muscle weakness;
* Skin rashes;
* Mood swings;
* Memory loss;
* Mental disturbances.

Methylmercury has been shown to cause tumors in mice at high doses. It is classified as a reproductive toxin, because data indicate that methylmercury could increase the frequency of mutation in human eggs and sperm. Methylmercury is also an endocrine-disrupting chemical, impairing normal thyroid functions, but these effects appear only at very high exposures.
MERCURY IN THE HEALTH CARE SECTOR: 
THE COST OF ALTERNATIVE PRODUCTS

November, 1996
ACKNOWLEDGEMENTS

Pollution Probe and the authors (Bruce Lourie, Cristina Giannetas, and Elaine Lukey) wish to thank the many individuals and health care facilities who provided us with information, guidance, and advice, especially the members of the Ontario Mercury Health Care Steering Committee, and the hospitals who completed the mercury inventory.

Hospital for Sick Children
Centenary Health Centre
The Toronto Hospital
Etobicoke General Hospital
North York Branson Hospital
North York General Hospital
St. Joseph’s Health Centre

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DISCLAIMER

This report was written to provide health care facilities with some general cost information on mercury containing products and alternatives. Actual costs will vary depending on item, number of items purchased, supplier, and other factors. The list of mercury containing equipment, chemicals and alternatives mentioned is not exhaustive. Additional costs associated with use of mercury containing equipment and products such as clean-up, training, disposal, and environmental costs will vary according to procedures used at individual facilities.

While reasonable attempts have been made to ensure the accuracy of the information, health care facilities will need to undertake their own purchasing and product reviews for use in their individual facilities. Pollution Probe and Environment Canada do not promote or endorse the suppliers or alternatives in this report and offer this report only as a source of information.
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Appendix 1: Ontario Mercury Health Care Steering Committee
Appendix 2: Mercury Reduction in the Health Care Sector: A Guide to Sources and Alternatives (Environment Canada)
EXECUTIVE SUMMARY

The health care industry, including hospitals, dental clinics, and the pharmaceutical industry, releases mercury into the environment through the use of mercury containing products. Hospitals in Ontario, together with Pollution Probe, recognized the need to develop cost information on mercury free products to assist with the process of reducing mercury use.

The goals of this report are:

1. To gather specific information on the costs of mercury containing products, mercury-free alternative, and to compare the two.

2. To provide information on often hidden or unaccounted for costs (direct and indirect) associated with the use of mercury containing equipment and products in health care facilities.

3. To discuss the concepts of environmental management systems (EMS), life-cycle analysis, and ecological economics as they relate to mercury in the environment, and the associated environmental costs.

4. To synthesize the information in goals 1 through 3 so that hospitals will have a better understanding of the costs associated with the use of mercury containing equipment and products; and to assist health care facilities in making informed decisions with respect to mercury reduction.

The findings of this study show that hospitals will likely save money by phasing-out the use of mercury products and related mercury handling and disposal requirements.

Seven hospitals completed a survey of the mercury containing products currently used in their facilities: Centenary Health Centre; Etobicoke General Hospital; Hospital for Sick Children; North York Branson Hospital; North York General Hospital; St. Joseph’s Health Centre, and the Toronto Hospital.

In general, mercury in Ontario hospitals is used in four general areas: medical equipment (e.g. sphygmanomanometer, thermometer); lab chemicals and pharmaceuticals (e.g. Thimerosal, Mercuric chloride); dental amalgams from hospital dental clinic; and in general use (fluorescent lighting, switches, batteries). Appendix 2 contains the Mercury Reduction in the Health Care Sector: A Guide to Sources and Alternatives by Environment Canada which outlines the most commonly used mercury products along with suggested alternatives.

Traditional economics does not consider the true price of using toxic substances such as mercury. This report separates the costs associated with the use of mercury products into direct and indirect costs. Direct costs include purchase price, hazardous waste training,
mercury spill clean up, waste storage and disposal, potential non-compliance costs (fines, sampling, staff time, cleaning traps and drains), and potential health risks to staff, patients, and visitors. Indirect costs including environmental costs and health costs for the general public are discussed in general terms.

It is difficult to compare mercury and non-mercury equipment on the basis of purchase price alone since no two pieces of equipment are identical and there are many factors which hospitals need to consider in their purchasing specifications including: safety (patient & staff), ease of use, efficacy, warranty, time savings, and preferences of medical staff.

In terms of initial purchase price, mercury containing diagnostic equipment was found generally to be less expensive, however, when other direct and indirect costs are considered the mercury free equipment was found to be cost effective and the preferred option in the long term. Hospitals already consider factors other than cost in their decisions. In fact, cost is often applied secondarily, after a specific product is identified. Avoiding the purchase of toxic products is a natural progression in health care decision-making, as it considers the risks to staff and patients, the costs of handling toxic waste, and the broader issue of environmental health and quality. These factors translate into direct benefits to the hospital.

For lab and pharmaceutical chemicals the price of the chemicals is not a major factor, therefore, motivating people to change the way they undertake procedures is key, and this requires increased awareness and education. Hospitals in the United States that have replaced their lab chemicals with mercury free alternatives found that costs were about the same. The most effective way to replace mercury containing pharmaceuticals and lab chemicals is by developing a mercury free purchase policy which puts the onus on suppliers and vendors to provide mercury free chemicals where possible.

There are many reasons why hospitals are reducing and eliminating mercury and other toxic substances from their facilities. These include: reducing the risk of accidental spills or discharges; not wanting to contribute to environmental impairment; obtaining savings through waste reduction; demonstrating leadership in the community; complying with requirements of present and future legislation and international environmental agreements; and responding to a perceived ethical obligation.

The missions of hospitals are moving toward broader definitions of disease prevention, patient health care and community well-being. The use of mercury in hospitals and the resulting emissions to air and discharges to water contribute to environmental and health problems for people and wildlife. Hospitals recognize this inconsistency and as community health care leaders play an important role in achieving the goal of mercury elimination and reduction.
1. INTRODUCTION

1.1 Background

Mercury is a bioaccumulative, persistent, toxic substance which threatens the health of humans and wildlife. Mercury is a neurotoxin and can cause damage to the brain, kidneys, and lungs, as well as to the nervous system. Symptoms of mercury poisoning can include; tremors, memory loss, muscle weakness, mood swings, and skin rashes. Mercury poisoning can be difficult to diagnose since the symptoms are common to other afflictions (California Department of Health Services, 1994). Elemental mercury, if inhaled as a vapour by humans, is quickly absorbed (approximately 80%) and can travel across blood-brain and placental barriers (USPHS, 1992). When inhaled, elemental mercury has a biological half-life of approximately 60 days (USPHS, 1992).

Mercury’s chemical state changes readily from solid to liquid to gas, and therefore circulates constantly in the environment. Three major forms of chemical mercury circulate in the earth’s atmosphere: mercury zero (Hg⁰), mercury two (Hg (II)), and methylmercury (CH₃Hg⁺). Methylmercury is the most harmful since it bioaccumulates in the muscle of living tissue (Figure 1).

The International Joint Commission (IJC) has identified mercury as one of 11 Critical Pollutants in the Great Lakes, and numerous other agencies and governments have targeted mercury as a leading candidate for phase-out, including Environment Canada, the US Environmental Protection Agency (EPA), the North American Commission on Environmental Cooperation, and provincial and state governments.

Over the past two years, Pollution Probe has focused its research on the Mercury Elimination and Reduction Challenge (MERC) project funded by Environment Canada and the Ontario Ministry of Environment and Energy. Probe’s *Mercury in Ontario: An Inventory of Sources, Uses, and Releases* report (Sang and Lourie, 1996) and other studies have identified that the health industry including: hospitals, dental clinics, and the pharmaceutical industry release mercury into the environment through the use of mercury and mercury containing products.

As part of the MERC project, a pollution prevention Memorandum of Understanding (MOU) to voluntarily reduce and eliminate the use of mercury in hospitals was signed in April, 1996 by three major hospitals in Toronto: Centenary Health Centre, Hospital for Sick Children, and The Toronto Hospital; as well as Environment Canada, the Ontario Ministry of Environment and Energy, the Health Care Environment Network, and Pollution Probe. These signatories formed the Ontario Mercury Health Care Steering Committee (Appendix 1). The Steering Committee was formed to encourage information sharing and to promote the elimination and reduction of mercury containing products in the health care sector. The Steering Committee and project continue to expand as hospitals from across Ontario and in other provinces become involved in the project.
Figure 1: Mercury in the Environment.

Source: Sang and Lourie (1996)
1.2 Purpose

In the course of the Mercury in Health Care Steering Committee’s work to reduce mercury in hospitals, a number of barriers were identified which need to be addressed in order to implement the full objectives of the MERC project. One of the key barriers identified in reducing the use of mercury-bearing products is demonstrating to hospital staff and administration that reducing or eliminating mercury containing equipment and products is cost effective.

The goals of this report are therefore as follows:

1. To gather specific information on the costs of mercury containing products, mercury-free alternatives, and to compare the two.

2. To provide information on often hidden or unaccounted for costs (direct and indirect) associated with the use of mercury containing equipment and products in health care facilities.

3. To discuss the concepts of environmental management systems (EMS), life-cycle analysis, and ecological economics as they relate to mercury in the environment, and the associated environmental costs.

4. To synthesize the information in goals 1 through 3 so that hospitals will have a better understanding of the costs associated with the use of mercury containing equipment and products; and to assist health care facilities in making informed decisions with respect to mercury reduction.

The process hospitals establish to reduce or eliminate mercury use in hospitals can be used as a framework for other toxic substances currently used in hospitals. Reducing mercury in the hospital sector can also provide a framework for reducing mercury in other industrial sectors.

Reasons for businesses and organizations to adopt pollution prevention initiatives include (Ibbotson & Phyper, 1996):

1. Reducing the probability of accidental spills/discharges and environmental impairment (e.g. health impact and costs, risk reductions for employees, patients, and the environment).

2. Obtaining savings through waste reduction.

3. Complying with requirements of present and future legislation as well as international environmental agreements.

4. Responding to a perceived ethical obligation.

5. Assisting in marketing (for hospitals this includes communicating environmental achievements to staff, patients, and the community at large).

These reasons for undertaking pollution prevention are also all important considerations for hospitals. For instance, although marketing may not appear to be as important to hospitals as to large corporations, in fact, hospitals are seen as community leaders and recognize the need to achieve a high standard of performance and community visibility. This performance may come under increasing scrutiny as hospital services open up to more competitive pressures.
Responding to a perceived ethical obligation may be a stronger motivation for hospitals versus profit-making corporations to act as environmental leaders. The missions of hospitals are moving toward broader definitions of disease prevention, patient health care and community well-being. The use of mercury in hospitals and the resulting emissions to air and discharges to water contribute to environmental and health problems for people and wildlife. This is not consistent with the goals of promoting health and well-being.

1.3 Methodology

In order to encourage and assist hospitals in their mercury elimination and reduction efforts, this report provides information on the cost effectiveness of alternatives to mercury containing products in the health care sector. Definitions and methods for allocating costs into direct and indirect categories vary. In this analysis, the direct costs to hospitals includes the initial purchase price, and other costs associated with the use of mercury containing equipment and products such as: clean-up of spills, training, hazardous waste storage and disposal costs. As well, potential non-compliance costs, and health risks to staff and patients from spills and product use will be considered a direct cost (although contingent) since exposure could occur on hospital grounds which could make the hospital potentially responsible and/or liable for compensation. Environmental costs and potential health effects to the general public (outside the hospital) will be considered indirect costs to the hospital.

Since the goal of this report is to be a practical guide on the cost-effectiveness of mercury alternatives for hospitals in Ontario, information on hospital purchasing considerations and procedures has been collected and is presented in Section 2.4. Information used in the preparation of this report included: analyzing mercury inventory lists completed by participating hospitals, talking to hospital staff, and contacting suppliers and purchasing agents for pricing information. General information on the environmental costs associated with toxic pollution is based on a review of several key sources, with emphasis on a major review of the literature conducted for Pollution Probe by Renzetti et al. (1993).

Guidance for this project was provided by the Ontario Mercury Health Care Steering Committee (Appendix 1) and by three external advisors with expertise in the economics of phasing out toxic substances and ecological economics: Robert Gale (Royal Roads University, B.C.), Tom Muir (Canada Centre for Inland Waters, Environment Canada, Burlington), and Ellie Perkins (York University).

1.4 Format

Section 2 outlines the assumptions underlying traditional cost/benefit analysis (CBA) and neoclassical economics, and explains the theory of ecological economics. The present use of mercury in hospitals is summarized in Section 3 using an inventory list that Pollution Probe developed in May of 1996 as well as the Mercury Reduction in the Health Care Sector: A Guide to Sources and Alternatives produced by Environment Canada (Appendix 2). Direct costs of the mercury-containing products and the mercury-free alternatives are discussed in Section 4. Section 5 outlines indirect environmental and health costs associated with mercury use in hospitals, and their role in the decision-making process of hospital purchasing. Section 6 compares costs of mercury and non-mercury sphygmomanometers and Section 7 summarizes the major findings of this report.
1.5 Limitations

One limitation faced in this type of analysis is the variability of costs between hospitals and between suppliers. Prices of goods purchased and costs of disposal vary according to purchasing power and waste quantities generated by each individual hospital. Costs stated in this report are generally quotes on a single item from one or two suppliers and therefore do not represent average prices from all suppliers nor prices for bulk purchases. Therefore, price and cost information obtained by individual hospitals may vary accordingly. Furthermore, mercury is found in many different chemicals and in many different uses. Cost information presented is mainly for equipment and products which are documented as being commonly used in hospitals.

Accurate estimates of the costs and risks of pollution directly linked to mercury in the environment and humans health can be difficult to quantify since exposure may or may not occur (e.g. spill) and detrimental health effects may be difficult to attribute to mercury. Exposure to many persistent toxic substances and other health risks makes it difficult to isolate the effects of mercury on humans or wildlife, except in cases of gross exposure. Ironically, the more widespread the toxic substance the more difficult it is to isolate chronic exposure because traditional methods of study depend on exposure differences to reveal effects (IJC, 1993). Costs of mercury use on environment and on human health (outside the hospital) will be considered indirect costs since these costs are incurred by society not by the hospital itself.
2. ECONOMIC ANALYSES AND MANAGEMENT

2.1 "Traditional" Economic Analysis

Traditional or Neoclassical economics generally guide the purchasing decisions made in hospitals, most industries, and many individual purchases. Neoclassical economics focuses on market transactions, where the market is allocating scarce resources in the most efficient way possible (Gowdy and O’Hara, 1995). Neoclassical economics thus tends to reflect private costs (costs to the organization making the decision) in a traditional Cost Benefit Analysis; while social costs (costs to society of the proposed transaction) and environmental costs, are generally not considered.

The theory assumes that all natural resources are free, and without value until determined by the market. It also assumes that the natural environment has a limitless ability to absorb pollution and waste, and to provide new resources (Peet, 1992). In essence, the fundamental assumptions which underlie traditional economic theory are at best questionable, and perhaps no longer acceptable given our broader societal and environmental objectives.

Neoclassical economists use several tools to attempt to accommodate social and environmental costs, including Cost/benefit Analysis (CBA), Cost-Effectiveness Analysis, Impact Analysis, using methods to value environmental externalities such as contingent valuation and the travel cost approach. For more information on the drawbacks of relying on neoclassical economic decision-making see Constanza (1991), Gowdy and O’Hara (1995), and Gale (1996) for a discussion on the shortcomings of this theory.

2.2 Ecological Economics

The costs associated with mercury use in this report will be analyzed using a combination of impact analysis and ecological economic theory, in an attempt to provide a more comprehensive analysis of the full cost of using mercury. Ecological Economics is an approach which aims to improve on economic theory but does not completely replace traditional economic analysis. Ecological economics is an economic theory that provides a systems perspective. It stresses the importance of considering the economy as a subsystem of the environment, since our present economic system is completely dependent on an ecological base. This is opposite to the neoclassical view that the environment is a subset of the economy -- referred to as an “externality”.

According to Berkes (1993), the four main characteristics of ecological economics provide:

1. Holistic view of the environment-economy system;
2. View of the economic system as a subset of the natural system of the earth;
3. Primary concern with natural capital, resources and environmental services as the basis of any economic activity;
4. Greater concern with a wider range of human values (such as health, dignity and a moral obligation towards future generations).
2.3 Environmental Management Systems

Since the late 1980s there has been a great deal of interest in improving procurement policies for organizations. This interest is part of a growing trend towards establishing environmental standards for organizations. The International Organization for Standardization (ISO) has developed a series of standards or guidelines known as ISO 14000 in the following areas:

- Environmental Management Systems (EMS)
- Environmental Auditing
- Life Cycle Assessment (LCA)
- Ecolabelling
- Environmental Performance Evaluation (EPE)

Many of the ISO 14000 environmental management standards have been or are in the process of being adopted by the Canadian Standards Association and are shaping corporate attitudes towards the environment. The five management tools listed above are important in understanding and promoting the economics of phasing out toxic substances such as mercury.

Hospitals could, for example, integrate an Environmental Management System into their present management structure to better manage environmental issues (including mercury) and demonstrate due diligence. An Environmental Auditing standard would be useful to ensure that the EMS is effective, and to ensure that the health care facility is in compliance with legislation and their own policies. It is, however, important to recognize that ISO 14000 and EMS are not environmental standards and do not specify or require the reduction in use of any particular product or substance. They merely provide processes for management decisions. LCA and Ecolabelling could assist in making procurement decisions that reduce environmental impacts. Finally, EPE could be used to guide corporate performance improvements on a regular basis.

Life Cycle Assessment & Total Cost Assessment

Life-Cycle Assessment (LCA) is a "cradle to grave" method of tracking resource use, production processes, consumption, disposal, and waste costs during a product's life cycle. Cost factors such as by-products produced and the ability to recycle can also be included. This analysis allows a more accurate comparison of the full spectrum of environmental costs associated with different products (Phyper & Ibbotson, 1996). In some cases, the product itself may appear environmentally benign, yet its production or disposal may result in serious environmental harm. LCA helps to identify and quantify these costs.
2.4 Hospital Purchasing Practices

Hospital purchasing decisions are based on many complex variables and take into account the perspectives and expertise of various staff and departments. Products and instruments are rarely switched without careful consideration of the effectiveness and efficacy of the choice. Requests for products or equipment are usually generated by department heads, such as the nursing manager. In many cases, a department representative works with both the biomedical engineering department and the purchasing agent to develop the required specifications for the equipment or products to be purchased (Macdonald, 1996; Westman, 1996). The factors and criteria that typically influence product purchasing decisions for hospitals include: cost, safety (patient and staff), ease of use, efficacy, life expectancy, warranty, ease of repairs, time savings, and the preference of a particular doctor or department.

These specifications or minimum standards are sent to various vendors, who are requested to submit proposals on the specifications. In many cases, vendors are selected by their ability to provide a broad range of equipment and products from various manufacturers and suppliers. Typically there are no environmental requirements in the specifications unless required by law. Vendors may be required to indicate that their products meet environmental, or more commonly, safety standards (Macdonald, 1996; Westman, 1996). Hospitals already include criteria other than price in their purchase decisions, therefore, in many ways considering environmental costs is a natural progression in the decision making process, with the secondary benefit of reducing health risks and possibly costs.

If a hospital wishes to substitute a product or piece of equipment, an analysis and a controlled trial of the new product must occur prior to the product’s introduction into the hospital for general use. Usually, some type of product evaluation committee tests new products and then recommends whether or not it is suitable for the proposed purpose. The evaluation committee usually has representation from each major area or department in the hospital such as: maintenance, biomedical/medical engineering, health and safety, materials management and purchasing, and various surgical and clinical departments in the hospital. There can also be additional or guest members on the evaluation committee for specialized products, for example, for products used in the anesthesiology department (Macdonald, 1996; Westman 1996). The length of the trial period depends on the product being tested and can take anywhere from one to six months.

Most hospitals seem to have some environmental policies in place, especially for recycling, waste reduction, and health and safety. However, most do not appear to have formal, written policies for purchasing more environmentally friendly products or for looking at alternatives to products containing toxic substances, including mercury. Growing concern and awareness about the environment has resulted in hospital staff selecting or purchasing more environmentally sound products informally. While these efforts are significant, it is important to have formal, written purchasing policies otherwise it is easy to overlook or ignore the policy especially when there are several individuals and departments involved in the purchase decision.
3. MERCURY USE IN HOSPITALS

3.1 Inventory of Mercury Products Used in Hospitals

In order to gain a better understanding of the presence of mercury in hospitals, several hospitals were asked to complete an inventory of mercury containing products and equipment used in their facility. The inventory survey was based on information from two different US sources and information provided by the Mercury Steering Committee members. For further information on commonly used mercury containing equipment and chemicals please see the Mercury Reduction in the Health Care Sector: A Guide to Sources and Alternatives (Appendix 2). The following hospitals completed the mercury product survey: Centenary Health Centre; Etobicoke General Hospital; Hospital for Sick Children; North York Branson Hospital; North York General Hospital; St. Joseph’s Health Centre, and the Toronto Hospital. All facilities are located in the Greater Toronto Area.

The results from the surveys indicate that there are four major categories of use for mercury containing products in hospitals, summarized in Table 3.1.

<table>
<thead>
<tr>
<th>Category of Use</th>
<th>Equipment/Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Medical Equipment</td>
<td>thermometers, sphygmomanometers, barometers, manometers, esophageal dilator</td>
</tr>
<tr>
<td>2. Lab Chemicals/Pharmaceuticals</td>
<td>Mercury (II) chloride, Thimerosal</td>
</tr>
<tr>
<td>*3. Dental Clinic</td>
<td>*dental amalgams</td>
</tr>
<tr>
<td>4. General Use Products</td>
<td>fluorescent lamps, batteries, switches, thermostats, cleaners, microwave ovens, plastics</td>
</tr>
</tbody>
</table>

*Not all hospitals have dental clinics.

Note: Please see Appendix 2 for more information on mercury containing products and alternatives.

3.1.1 Medical Equipment

Mercury (Hg) is found in various types of hospital equipment, however, the most easily identifiable and numerous are thermometers and blood pressure monitors (sphygmomanometers). Numbers of thermometers at each facility ranged from about 15 to 1,200. Numbers of sphygmomanometers ranged from about 5 to 300. These numbers depend on how far along hospitals are in their phase out efforts, as well as the hospital’s function. In one Quebec survey, 80% of 28 hospitals surveyed still use mercury sphygmomanometers and 45% use mercury thermometers (Guerrier et. al., 1994). Some hospitals also use Hg containing barometers, oxygen and fetal monitors, esophageal dilators, nursing incubator thermostats, old microwave ovens, and otoscopes. It can be difficult to obtain exact numbers on mercury containing equipment since some of the equipment (e.g. thermometers) are used in many varied applications throughout a hospital. In other cases it may not always be apparent that the equipment contains mercury.
3.1.2 Lab Chemicals and Pharmaceuticals

According to the hospital surveys, the most commonly used mercury containing chemicals were: Mercury (II) chloride (Mercuric chloride); Thimerosal (Merthiolate); Zenker's/Lilly's buffered solution (contains Mercury (II) chloride); B5 Fixative (contains Mercury (II) chloride); Schaudinn's Fixative (contains Mercury (II) chloride); Mercurochrome; and Mercury (II) oxide. These chemicals were mainly used for the following purposes: histology, microbiology, pathology, histopathology, cytopathology, and necropsy. Several other compounds identified are used mainly for research: metal mercury; Phenylmercuric acetate; Mercuric iodide; Mercuric oxide (red); Mercuric oxide (yellow); Mercuric nitrate; and Mercuric thiocyanate.

Lab compounds are prepared in house, as needed, and therefore are kept in small quantities. Mercury is used in many different products and applications and may be “hidden” in the formulation. One of the challenges for completely eliminating mercury use, is its widespread presence in trace amounts in chemicals (<1%). Mercury may also be a proprietary ingredient in a formulation and therefore not listed on Material Safety Data Sheets (Terrene Institute, 1995).

The Massachusetts Water Resources Authority and the Massachusetts Academic and Scientific Community Organization (MASCO) have so far established a database of 5,500 products and chemicals 800 of which contain detectable mercury (>1 ppb). They note that one of the major challenges for hospitals is the fact that mercury accumulates in drain traps and piping systems and can reside there indefinitely, contributing to water discharges even after mercury use has been reduced. MASCO has set up an Internet web site describing their project and the products tested for presence of mercury (http://www.masco.org) (Eppstein, 1996).

The most effective way for hospitals to reduce mercury containing chemicals is to establish a purchasing policy that puts the onus on the supplier or vendor to supply mercury free chemicals (where possible). Riverside Osteopathic Hospital in Michigan had the suppliers’ sales managers sign an agreement to this effect (Smith, 1996a).

3.1.3 Dental Clinics

Dental amalgams are found in health care facilities which have dental clinics. Dental amalgams used for tooth restoration contain elemental mercury. Amalgams are a mixture of mercury (approximately 50% metallic mercury by weight), silver, copper, and tin which quickly harden together into a solid. Dental practices can be a relatively significant source of mercury to the environment. Hospitals often overlook this source of mercury, perhaps because dental clinics operate somewhat separately from the rest of the hospital.

Mercury in dental amalgam is not in a stable form, and it is well documented that mercury vapour is released from dental amalgam fillings (Hanson, 1990). When the amalgam is drilled and suctioned from the mouth, it is collected by a high volume evacuation (HVE) system and from there, it is often sent down the drain to be discharged to the sewer system. Increasingly, dental offices are installing mercury traps to collect mercury before it enters the sewer system. However, the mercury still needs to be recycled or disposed of, and could end up being incinerated.

A study conducted by the San Francisco Department of Public Works in 1993, found that the daily loading of mercury from each dental office is about 0.132 lb/day, which accounted for 8% and 13% of the total mercury-containing waste coming into city treatment plants (City and County of San Francisco, 1993). Mercury may also be released into the environment during the preparation of dental amalgam as a result of scraps and spills, which accounts for 2% of total mercury used in dentistry.
3.1.4 General Use Products

Fluorescent Lamps
All hospitals (and virtually all commercial buildings) use fluorescent lamps for lighting. Fluorescent lamps contain mercury and currently there is no mercury free technology available. High pressure sodium lamps and ultraviolet lamps also contain mercury vapour, therefore, it is important that they are recycled (see Section 3.2).

Batteries
The Canadian Household Battery Manufacturers' Association (CHBA) has eliminated the use of mercury in household alkaline batteries as of January, 1997 (Antler, 1996). However, mercury may still be found in more specialized batteries used in scientific equipment. For instance, Centenary found that they were using mercury batteries in their pagers, and are now starting to replace these pagers.

The CHBA plans to implement a Nickel-Cadmium (rechargeable battery) recycling program (Charge Up to Recycle) for households, businesses, institutions, and government. Hospitals could send their used batteries to the CHBA's consolidation centre. The batteries would then be sent to a battery recycler in the U.S. (Inmetco) at the expense of the CHBA and the Rechargeable Battery Recycling Corporation (RBRC) (Antler, 1996).

Thermostats and Switches
Mercury switches are fairly common especially in older buildings and equipment, therefore, just about all hospitals will have mercury thermostats and switches.

Cleaners
Certain cleaning products contain small amounts of mercury (Harvie, 1996; Brachman, 1996). This could potentially be a significant source for hospitals since hospitals use large amounts of cleaning products in their daily operations.

Plastics
Some studies found that pigmented plastics such as red bags and blood tube caps may also contain mercury. Mercury is used in combination with cadmium compounds to produce red and maroon pigments suitable for use in plastics (Sang & Lourie, 1996).
3.2 Alternatives to Mercury Products

Virtually every mercury containing product used in a hospital has a mercury free alternative. The most commonly used products and some mercury free alternatives are listed in Appendix 2 and Table 4.1a. Appendix 2 is a guide prepared by Environment Canada in collaboration with Pollution Probe and the Ontario Mercury Steering Committee entitled *Mercury Reduction in the Health Care Sector: A Guide to Sources and Alternatives*. Alternatives to mercury containing products are used in many hospitals, for example, electronic thermometers and certain lab chemicals. The major exceptions are lamps, such as fluorescent, high intensity discharge, high pressure sodium, and ultraviolet. The amount of mercury used in these lamps has decreased significantly over the past decade. Following is a summary of the primary alternatives and relevant information on product replacement.

3.2.1 Medical Equipment

Medical equipment is where the most obvious mercury exists in hospitals. There are mercury free alternatives for all of the commonly used medical equipment. Specific products and alternatives are described in Table 4.1a. The primary issue for equipment replacement does not appear to be cost, but product performance and personal preference. For example, hospitals have been replacing mercury thermometers with digital or tympanic thermometers which may cost 100 times more, but save time. In some hospitals, mercury sphygmomanometers are considered to have the best performance and the more modern mercury free aneroid devices are resisted.

3.2.2 Lab Chemicals and Pharmaceuticals

Mercury free lab chemicals and pharmaceuticals are widely available for most applications. The primary issue for lab chemicals and pharmaceuticals appears to be general awareness of the presence of mercury, followed by the identification and specification of alternatives.

3.2.3 Dental Clinics

Mercury amalgam is still the most commonly used substance for dental restoration. A growing number of dentists use non-mercury composites which are widely available. The Canadian and American Dental Associations are still recommending the use of mercury amalgam. There are opportunities for reducing the amount of mercury leaving dental clinics by installing mercury traps in drains and sinks.
3.2.4 General Use Products

Fluorescent Lamps and Energy Efficiency
One of the primary contributors to atmospheric mercury is the burning of fossil fuels, especially coal. Hospitals use a relatively large amount of electricity due to constant lighting requirements, specialized equipment, and summer cooling requirements. One way that hospitals can decrease the amount of mercury going into the environment is by becoming more energy efficient, for example, by using more energy efficient fluorescent lamps.

An added benefit of the more energy efficient T8 fluorescent lamps is that they contain about 66% less mercury than the commonly used T12 fluorescent lamps which contain approximately 22.8 mg of mercury per four foot lamp (Chong, 1996). Once removed, fluorescent lamps need to be recycled since all fluorescent lamps contain mercury and there is no viable alternative. Centenary Health Centre and The Hospital for Sick Children have recently undertaken an energy efficiency retrofit of their facility in order to reduce their electricity consumption and to save money. A retrofit of high efficiency lamps and ballasts can pay for itself in under one year.

Batteries
There are many viable and cost-effective alternatives to mercury batteries. The battery industry has eliminated the production of most mercury containing batteries, although a few specialized mercury oxide batteries continue to be sold in North America. These are frequently “button” batteries used in pagers and certain specialized equipment, including fetal heart monitors and portable cardiac equipment. Non-mercury rechargeable batteries are generally more cost-effective.

Thermostats and Switches
Mercury free thermostats and switches are readily available and tend to offer features that make them more appealing, such as programmability.

Cleaners and Plastics
Mercury free cleaners and plastic products are widely available and cost considerations are not an issue.
4. **HOSPITAL COSTS (DIRECT)**

4.1 **Purchase Price (Mercury Containing Products and Alternatives)**

Several sources were contacted to obtain the pricing information on mercury containing equipment and products, presented in Table 4.1a. Where available, the amount of mercury is included for the mercury containing products. Costs such as: time for purchasing, stocking, handling incoming products are assumed to be the same for the mercury-containing product as the mercury-free alternatives and are not considered in this analysis. The purchase price of the product is only one of a number of costs that must be considered.

Prices listed in this report may be 10-30% higher than the actual prices paid by a specific hospital when dealing with the same suppliers and products in a tendering situation, reflecting discounts for volume purchases (Westman, 1996).

Purchasing mercury free products will likely save hospitals money. On the basis of only initial purchase price, the mercury-free alternatives listed in the table are generally more expensive than the mercury-containing products. However, the purchase price does not reflect the true cost of the product, since it does not include costs of: clean-up; storage and disposal; hazardous waste training; potential risks to staff, patients, and visitors; and potential costs of non-compliance. The purchase price also does not consider the environmental and health effects associated with mercury use for the public. Moreover, an added benefit of using aneroid thermometers is that a few minutes of a nurse's time since can generally be saved by obtaining a quicker temperature reading.

If a hospital applies Full Cost Pricing, according to the principles of ecological economics, to calculate the true costs attached to the mercury-containing product, the mercury-free alternative becomes the most cost-effective approach. As well, if all health facilities started requesting mercury free products it is likely that the purchase price for these products would decrease. For instance, the Envirosafe (mercury free) immersion thermometer is cheaper than the Ertco immersion mercury thermometer (See Table 4.1a).
<table>
<thead>
<tr>
<th>PRODUCT &amp; #</th>
<th>MERCURY CONTENT</th>
<th>PRICE</th>
<th>ALTERNATIVE &amp; #</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIAGNOSTIC EQUIPMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphygmomanometers</td>
<td>83.7 g</td>
<td>$153.00\textsuperscript{1}</td>
<td>aneroid wall #7670-01</td>
<td>$170\textsuperscript{1}</td>
</tr>
<tr>
<td>desk style #5097-30</td>
<td>95.5 g</td>
<td>$264.70\textsuperscript{1}</td>
<td>aneroid mobile #7670-03</td>
<td>$300\textsuperscript{1}</td>
</tr>
<tr>
<td>mobile with stand #5097-29</td>
<td>83.7 g</td>
<td>$136.90\textsuperscript{1}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wall mount #5097-26</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermometers</td>
<td>83.7 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rectal</td>
<td>.065 ml\textsuperscript{2}</td>
<td>range $3-8\textsuperscript{3}$</td>
<td>1. Geratherm</td>
<td>$5-8\textsuperscript{10}$</td>
</tr>
<tr>
<td>oral</td>
<td>.060 ml\textsuperscript{2}</td>
<td></td>
<td>2. electronic-battery operated</td>
<td>$13-16\textsuperscript{2}$</td>
</tr>
<tr>
<td>basal</td>
<td>.133 ml\textsuperscript{2}</td>
<td></td>
<td>3. range</td>
<td>$219-380\textsuperscript{3}$</td>
</tr>
<tr>
<td>Ertco Immersion (-20 to 150°C)</td>
<td></td>
<td>$54.20\textsuperscript{9}$</td>
<td>4. infrared aural #01950-200</td>
<td>$427\textsuperscript{1}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. electronic #01675-200</td>
<td>$470\textsuperscript{1}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enviro-safe Immersion (-20 to 150°C)</td>
<td></td>
<td>$23.20\textsuperscript{9}$</td>
</tr>
<tr>
<td>Weighted Esophageal Dilator</td>
<td>1.6 ounces\textsuperscript{4}</td>
<td>$97.80\textsuperscript{3}$</td>
<td>tungsten weighted</td>
<td>$157.85\textsuperscript{5+}$</td>
</tr>
<tr>
<td>16fr</td>
<td>31.7 ounces\textsuperscript{4}</td>
<td>$391\textsuperscript{3}$</td>
<td>20fr</td>
<td>$459.83\textsuperscript{3}$</td>
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<tr>
<td>60fr</td>
<td></td>
<td></td>
<td>60fr</td>
<td></td>
</tr>
<tr>
<td>Feeding Tubes*</td>
<td>N/A</td>
<td>N/A</td>
<td>1. all plastic 5fr-10fr</td>
<td>$69.65 / 50\textsuperscript{3}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. tungsten weight 6fr</td>
<td>$169.93/10\textsuperscript{4+}$</td>
</tr>
<tr>
<td>CHEMICALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td></td>
<td></td>
<td>Zinc Formalin</td>
<td></td>
</tr>
<tr>
<td>Hematoxylin</td>
<td>unavailable</td>
<td>$91.00\textsuperscript{6}$</td>
<td>1. Gill's hematoxylin #3</td>
<td>$113.40\textsuperscript{6}$</td>
</tr>
<tr>
<td>HHS-128 4Litre</td>
<td></td>
<td></td>
<td>GHS-3-128, 4Litre</td>
<td>$145.97\textsuperscript{7}$</td>
</tr>
<tr>
<td>immune saline</td>
<td></td>
<td></td>
<td>2. Sodium Iodate reagent grade, powder form, 500g bottle</td>
<td></td>
</tr>
<tr>
<td>mercurochrome</td>
<td>unavailable</td>
<td>$15.40\textsuperscript{6}$</td>
<td>1. Neosporin</td>
<td></td>
</tr>
<tr>
<td>for lab use only</td>
<td></td>
<td>$29.10\textsuperscript{6}$</td>
<td>2. Mycin</td>
<td></td>
</tr>
<tr>
<td>#M7011 10 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thimerosal</td>
<td>unavailable</td>
<td>$20\textsuperscript{6}$</td>
<td>Thimerosal-free bactericides</td>
<td></td>
</tr>
<tr>
<td>Sigma-ultra #78784 1 g</td>
<td>unavailable</td>
<td>$67\textsuperscript{6}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 g</td>
<td></td>
<td>$223.20\textsuperscript{6}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.1b: Costs of Mercury Spill Kits and Vacuum

<table>
<thead>
<tr>
<th>PRODUCT &amp; #</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEAN-UP</td>
<td></td>
</tr>
<tr>
<td>Mercury Spill Kits</td>
<td></td>
</tr>
<tr>
<td>Mercon Kit #1</td>
<td>$200&lt;sup&gt;8&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mercon Kit #2</td>
<td>$170&lt;sup&gt;8&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mercon Kit #3</td>
<td>$84&lt;sup&gt;8&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mercury Collector</td>
<td>$19.95&lt;sup&gt;11&lt;/sup&gt;</td>
</tr>
<tr>
<td>HSC (in-house)</td>
<td>$5 to 9&lt;sup&gt;12&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vacuum for Mercury</td>
<td>$2,000&lt;sup&gt;13&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*Suppliers contacted no longer sell feeding tubes that contain mercury.
+Converted from $US using the Royal Bank of Canada’s Average Conversion Rate, 1995 of 1.3726.

11. Mercury Collector, Bel-Art Products (Cat. No. 36250-0000) (Maslowski, 1996 pers. comm.)
13. Estimate of cost-purchased few years ago (Smith, 1996 pers. comm.)
4.2 Spill Clean-up

Most hospitals seem to have some type of spill recovery procedure, however, reporting of spills does not seem to be well documented. This is important since the number of breakages and mercury spills occurring in a hospital tend to be underestimated by hospital staff (Smith, 1996a). A Quebec survey of 28 hospitals indicated that 35% of hospitals did not have any recovery procedures in case of spillage and most mercury spills were apparently not reported. Breakage, spills, inadequate maintenance and disposal of equipment can expose employees and the public to mercury (Guerrier et. al., 1994).

Actual costs of cleaning up mercury spills are also not well documented, however, certain documented cases show that mercury spills can be very expensive to clean up. For instance, between 1993 and 1995, several spills at Butterworth Hospital in Grand Rapids, Michigan occurred which resulted in expensive clean-up and decontamination procedures, in part, because of the replacement of carpeting (approximately $3,000 US to clean up each mercury spill) (Stickles, 1994). As a result of these expensive clean-ups, Butterworth Hospital has made a commitment to become mercury free. To help them accomplish this goal they have instituted a purchasing department policy that unless there is not a suitable mercury free alternative, no mercury containing devices are to be purchased.

Mercury is a designated workplace substance, therefore stringent measures to clean up spilled mercury are essential. According to the Ontario Ministry of Labour guidelines these clean-up procedures should be written, thoroughly explained to all staff working with mercury, and posted in the workplace (MOL, 1986). Appropriate clean up measures and protective clothing must be worn when cleaning spills. According to the mercury regulation guide, small spills should be cleaned up immediately with a vacuum cleaner equipped with charcoal filter or water trap, or a hand held pipette used with a rubber bulb or water pump. Surfaces should then be washed with mercury neutralizing solution such as 20% calcium sulphide or 20% sodium thiosulphate (MOL, 1986). Sulphur powder can be sprinkled over the area immediately after spill occurs to prevent the mercury from vapourizing before the clean up is complete.

Using mercury not only involves potentially high clean up costs, but also administrative costs to keep procedures up to date and staff trained. In cases where major spills occur more stringent measures must be taken including evacuating the area, using respiratory gear, and posting warnings. The potential for a fairly large mercury spill occurs while mercury is being stockpiled and stored prior to recycling or disposal.

Clean up costs depend upon the number of spills, amount of time it takes for personnel to clean up the spill, wage rate, cost of mercury spill kits, training, and management time. Average wage rate of spill team members, range from $15 to $20+/hour (Smith 1996b; O'Grady, 1996). The wage rate can vary widely depending on the policy of the hospital on who cleans up the spill. Some hospitals have housekeeping clean the spill and other hospitals have the person who broke the equipment, such as a nurse, clean up the spill. It is estimated that a mercury spill clean up can take anywhere from 15 minutes up to 12 hours depending on the size and location of the spill, as well as the availability of knowledgeable people to clean up the spill (O'Grady, 1996; Smith, 1996a; Smith, 1996b).
This is an important factor to note since hospitals cannot afford to have busy staff personnel such as nurses take 15 minutes to 12 hours to properly clean up a spill. In a spill involving a sphygmomanometer, it can take up to 12 hours to clean up the area especially if it breaks against a bed and the mercury scatters all over the bed and the floor. The room would need to be closed off, the bed taken apart, and the entire room thoroughly cleaned. The cost of spill kits vary from $5.00-$200.00 depending on the contents and whether produced in-house or purchased externally. Another expense associated with spill clean-ups is protective clothing such as disposable gloves, shoe covers, and perhaps overalls to clean up the spill (if not already contained in the spill kits). For larger spills, special breathing apparatus may be required during clean-up, or monitoring equipment to ensure that mercury levels in the air meet safety and legal requirements.

4.3 Training

Use of mercury and other hazardous substances under WHMIS (Workplace Hazardous Materials Information System) requires that employees be properly trained on how to identify and use these substances. Training can be expensive especially for a substance such as mercury which can be found throughout the hospital; and since spills do not occur that often it is likely that staff will need to consult with either a manual or trained personnel for appropriate clean-up and disposal procedures. For each spill at least three or four different people would likely be involved with the following:

- clean-up of spill (15 minutes or greater);
- manager to whom spill reported or who gives advice on proper procedures (5 minutes or greater);
- replacement and for some hospitals production of spill kits (5 minutes or greater);
- proper recycling/disposal of mercury (5 minutes or greater).

Besides the costs associated with the actual training and staff time, there are administrative costs such as: keeping procedures updated and changes distributed to appropriate individuals, tracking who has been trained, filling out spill incidents reports and hazardous waste manifests. All these activities require training which can be time consuming and expensive.

4.4 Storage and Disposal

Under the Ontario waste management Regulation 347, mercury must be disposed of as a hazardous waste. Since it is considered hazardous waste, most hospitals store small amounts of mercury along with other hazardous materials, until the quantity is large enough to warrant a pickup. Separating out the cost of disposing of mercury by itself is difficult, since contracts with waste disposal companies generally do not isolate specific products.

The average cost to a hospital for the proper disposal of mercury is $250 per pick up of a 45 gallon drum called a ‘Labpack’ which is a mixture of different hazardous materials, each in a small quantity (Santostefano, 1996; O’Grady, 1996). Depending on the size and the functions of each hospital, the number of pickups per year will vary between facilities. Assuming the number of pickups is 10 per year, (based on Laidlaw’s information on number of pickups from major hospitals) the hospital is paying $2,500 just for the pickup of the small quantities of hazardous materials, including mercury, contained in the Labpack. Assuming further that 1/4 of an average Labpack is mercury and mercury contaminated waste (Santostefano, 1996), the cost for proper disposal of mercury would be $625/year.
4.5 Compliance Costs and Regulations

Ensuring Compliance

As a result of mercury's toxicity and well documented adverse human health and environmental effects, there are currently several pieces of federal, provincial, and municipal legislation that consider mercury.

Mercury has been identified as a persistent, toxic substance by the federal government under the Priority Substances List (PSL) of the Canadian Environmental Protection Act (CEPA). The Ontario Ministry of Environment & Energy (MOEE) lists mercury as one of 27 chemicals targeted for bans, phase-outs, or reduction; and mercury is a Tier I substance under the Canada-Ontario Agreement (COA). The International Joint Commission (IJC) identifies mercury as one of 11 Critical Pollutants (Sang and Lourie, 1996). The North American Free Trade Agreement (NAFTA) outlines mercury as one of four substances to be banned or phased out by Canada, the United States, and Mexico. The other three substances have already been banned in Canada and the US. Mercury is a designated substance in the workplace (Ontario), hazardous substance under WHMIS, discharges limited in sewer use by-laws, and maximum levels established for drinking water and fish consumption.

Costs for hospitals to comply with current regulations are not well documented. The costs of storing, treating, and disposing of waste is increasing, therefore, pollution prevention is increasingly cost-effective because it can provide savings, improve efficiency, and reduce the environmental liabilities of an organization (GLPPC, 1996). Part of the cost of using hazardous substances such as mercury is ensuring compliance with all current applicable municipal, provincial, and federal legislation. For planning purposes it is also important to keep up to date on proposed legislation. In order to do this each hospital needs to have staff who are familiar with and regularly verify and update all applicable environmental, and health and safety regulations for substances such as mercury.

Potential Non-Compliance

There are also potential costs associated with non-compliance of regulations including: remediation and fines, sampling and monitoring, staff time, and cleaning of drains and traps. In the United States, inability to comply with water discharge regulations for mercury has meant that hospitals have had to look closely at their operations. Mercury used in the past often settles at low points such as sumps and traps. This means that discharge violations for mercury can occur years after mercury is poured down the drain (GLPPC, 1996b). Hospitals in Minnesota which are not in compliance with mercury discharges to the sewer are required to undertake regular sampling and costly cleaning of drains and traps.

4.6 Human Health Risks (Staff and Patients)

In Ontario, mercury is a designated substance in the workplace as well as being covered under WHMIS. The maximum exposure of a worker to all mercury, except alkyl mercury compounds, must not be greater than 0.15 mg/m³ of air at any time. The maximum exposure to alkyl mercury compounds must not be greater than 0.03 mg/m³ (MOL, 1986). It is also important to note that the maximum concentration of airborne mercury must not last longer than 15 minutes at any one time which means that if a large enough spill occurs it may be necessary to have the person cleaning up the spill wear protective respiratory gear and/or close off the area and take air samples. There are also potential risks to patients and visitors since breakages have occurred when patients have knocked over equipment.
5. ENVIRONMENTAL AND HEALTH COSTS (INDIRECT)

Identifying and quantifying the costs to society and the economy from the use of toxic substances is an impossible task. Yet it is possible to begin to consider the nature of these costs and some estimates for certain kinds of costs we bear.

Specific costs related to mercury use and consequent environmental effects are very difficult to quantify. For instance, how much is it worth to decrease the amount of mercury in air, water, or soil from human activities by 1 ppm in terms of human health and the environment. Alternatively, how much is it worth to recreation and fishing enthusiasts to know that they can eat all the fish they can catch without fear of harming their health.

Costs to the natural environment of present practices can be very expensive. Estimates of cleaning up contaminated sites vary depending on the composition of chemicals, the geography, and the geology of the area. The cost to clean up a contaminated industrial site can easily exceed $10 million.

5.1 Cost of Polluted Great Lakes

Beneficial use impairments (i.e. inability to eat the fish or drink the water) resulting from mercury can be found throughout the Great Lakes ecosystem and smaller lakes throughout Ontario and the US Midwest. These impairments include: restrictions on fish consumption by humans, restrictions on dredging activities, and impairment of water and sediment quality based on exceedence of available criteria (Ontario MOEE, 1992). Mercury concentrations in occasional samples of water, sediment, sport fish, and biota of Lakes Superior, Erie, and Ontario; the St. Mary’s River System; and the St. Clair/Detroit River System often exceed the current Provincial Water Quality Objectives (PWQO) and the Great Lakes Water Quality Agreement (GLWQA). Similarly, concentrations in sediment and biota in Lake Huron, the Niagara River, and the St. Lawrence River have also exceeded the current criteria (Ontario MOEE, 1992).

Mercury is a problem in the Great Lakes basin and many of the small lakes in which 65 million people live and enjoy recreational activities. The environmental impacts of mercury affects both commercial and sport fishing industries. Loss of commercial fisheries is one of most easily identifiable losses of economic value. Cleaner lakes would likely increase both the commercial and sport fishing industries and create spin-off benefits for other sectors such as tourism and related activities.

"The Great Lakes attracted 2.5 million anglers in 1991; nationally, anglers fished an average of 14.5 days and spent an average of $728 per person on their sport (U.S. Fish and Wildlife Service, 1992) This equates to about $1.8 billion in annual economic impact in the Great Lakes region."

Mercury is so toxic, persistent, and bioaccumulative that The Guide to Eating Ontario Sport Fish (1995-1996) consumption restrictions for sport fish containing mercury begin at levels above 0.5 ppm (parts per million), with total restrictions advised for levels above 1.5...
ppm. These guidelines are based on federal guidelines supplemented by recommendations from the World Health Organization. In Ontario, the consumption of several species of fish is restricted as a result of mercury contamination in lakes. At the same time it is important to note that these guidelines do not take into account the possible synergistic effects associated with the presence of other heavy metals and toxics found in the water and soil.

Lost income estimates due to persistent toxic related closures or market losses include mercury in Lake St. Clair at about $5 million/year in 1990 dollars; mirex in Lake Ontario eel at $2 million/year; and persistent toxic substances in Lake Ontario carp and mirex in sport fish caught for sale at about $1.5 million/year (IJC, 1993).

If sport fishing were to increase by 10% in the Great Lakes due to decreased pollution, and decreased fish advisories, estimates of the economic impact show an increase of approximately $300 million each year. If the fishery is managed in a sustainable manner, this economic impact can be replicated each year for an indefinite period of time (National Wildlife Federation, 1993).

Cost of the loss to subsistence fishers has not been estimated nor losses due to injury of other wildlife (IJC, 1993). Several species of wildlife have shown reproductive problems attributable to chemical pollutants in the Great Lakes. These fish-eating species include eight birds, one reptile, and two mammals (Environment Canada et al., 1991).

5.2 Health Effects

Heavy metals such as mercury can impair human health and have medical costs. The most important benefit to society of reducing pollution is the decreased risk of illness and premature death. These risks occur because a large number of substances are emitted to the natural environment which cause negative health effects upon exposure to humans. For instance, low concentrations of substances such as mercury, PCB, and dioxin which are found in drinking water supplies may be associated with increased incidence of serious chronic illnesses including: certain forms of cancer; and adverse effects on neurological, immunological, and reproductive systems (Flint and Vena, 1991).

Benefits of reducing pollution can be difficult to evaluate in economic terms for a number of epidemiological reasons including: uncertainty surrounding the dose-response relationship for many toxic substances; the latency periods associated with some diseases; extent to which responses can be reduced by "defensive actions"; and the compounding effects of exposure to multiple substances. It can also be difficult to assign dollar values to avoided cancers, asthma, eye irritations, and the pain and suffering that accompany these illnesses.
5.3 Environmental Costs and Pollution Prevention

Costs to the environment and society are not included in the purchase price of products or equipment containing persistent toxics such as mercury. Environmental liabilities of current and past practices are usually ignored and not accounted for on financial statements. For instance, studies on the clean up cost of Canadian federally owned hazardous waste sites indicate that it will cost at least $2 billion to clean them up. The Canadian Auditor-General recently recommended that the federal government include their share of these environmental liabilities in their financial statements (Government of Canada, 1996). As well, based on standard practices, it is estimated that it will cost $6 billion US over the next thirty years and $19 billion US over the next 100 years to clean up just four of the largest clean-up sites on the Niagara River (IJC, 1993).

In order to meet the “self-sustaining sport fishery” water quality objective, annualized expenditures of between $135-$142.35 million would be required for Metro Toronto; and $9.49 million for Hamilton Harbour by local and provincial governments to reduce non-point urban runoff and to upgrade sewage treatment plants (Apogee Research International et. al., 1990).

Pollution prevention is generally a much more cost effective way of reducing environmental impacts than using pollution controls. For example, in Minnesota it is estimated that it costs approximately $2,500 to $3,500 US to remove one pound (0.4538 kg) of mercury from a municipal waste incinerator’s air emissions (Michigan Mercury Pollution Prevention Task Force, 1996). It is easier and cheaper to prevent pollution than to try to control the release after it has already occurred.
6. **COST COMPARISON (CASE STUDY)**

An attempt has been made to undertake a detailed comparison of the cost of a specific mercury bearing product versus a mercury free alternative. Table 6.1 compares the direct and indirect costs of a mercury and a non-mercury mobile sphygmomanometer. The analysis shows that, although the initial purchase price of the mercury sphygmomanometer is slightly higher, when clean-up estimates (lowest spill kit price, shortest clean-up time, lowest salary) and low disposal cost estimates are included the non-mercury sphygmomanometer becomes the more cost effective option. Furthermore, if you consider some of the health and environmental impacts, as well as the importance of due diligence and risk management, the cost of the mercury bearing product becomes much greater to the hospital and to society. This conforms to the general principle that pollution prevention is often the most cost effective choice, particularly in the long term.

The information presented in Table 6.1 indicates that even with a modest attempt to incorporate some of the direct and indirect costs associated with using a mercury sphygmomanometer, the mercury product exceeds the cost of the mercury free alternative. An estimate of the “difficult to quantify” categories would increase this total cost, perhaps significantly, demonstrating the optimum societal benefit of using mercury free products.
Table 6.1: Costs of Using Mercury and Aneroid Mobile Sphygmomanometers

<table>
<thead>
<tr>
<th>COSTS (Direct &amp; Indirect)</th>
<th>Mercury Sphygmomanometer mobile with stand #5097-29 (95.5g of Hg)</th>
<th>Sphygmomanometer aneroid mobile #7670-03</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIRECT COSTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase Price</td>
<td>$264.70</td>
<td>$300.00</td>
</tr>
<tr>
<td>Hg Component of Hazardous Waste &amp; Spill Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trainee (0.25 hr x $15.00)</td>
<td>$3.75</td>
<td></td>
</tr>
<tr>
<td>Trainer (0.25 hr x $20.00)</td>
<td>$5.00</td>
<td></td>
</tr>
<tr>
<td>Clean-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spill kit cost &amp; protective clothing</td>
<td>$5.00 to $300.00</td>
<td></td>
</tr>
<tr>
<td>Staff time (0.5 hr x $15.00/hr)</td>
<td>$7.50 to $180.00</td>
<td></td>
</tr>
<tr>
<td>(12 hr x $15.00/hr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration/Reporting of spill (0.25 hr x $15.00)</td>
<td>$3.75</td>
<td></td>
</tr>
<tr>
<td>Storage/handling (0.25 hr x $15.00/hr)</td>
<td>$9.00</td>
<td></td>
</tr>
<tr>
<td>Disposal (1 sphyg; estimate*)</td>
<td>1/20 x $225.00</td>
<td>$11.25</td>
</tr>
<tr>
<td>Non-compliance costs: fines, staff time, sampling &amp; monitoring, remediation, cleaning of drains and pipes.</td>
<td>Highly variable (see Section 4)</td>
<td></td>
</tr>
<tr>
<td>Human Health Risk (staff, patients, visitors)</td>
<td>Difficult to quantify (see Section 4)</td>
<td></td>
</tr>
<tr>
<td><strong>Total Indirect</strong></td>
<td></td>
<td>$309.95+ to 777.45</td>
</tr>
<tr>
<td><strong>INDIRECT COSTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incinerator to remove 1lb Hg from incinerator</td>
<td>$721 to $1,009</td>
<td></td>
</tr>
<tr>
<td>$2,500 to $3,500 US per 0.4538 kg (@1.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0955kg in 1 sphygmomanometer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Health Risk (general public)</td>
<td>Difficult to quantify (see Section 5)</td>
<td></td>
</tr>
<tr>
<td>Effects Air, Water, Soil, Wildlife</td>
<td>Difficult to quantify (see Section 5)</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>$1,031 to $1,786</td>
<td>$300.00</td>
</tr>
</tbody>
</table>

*Note: this is an example, actual costs will depend on various factors including quantities purchased, amount of mercury spilled, quantity disposed, location and nature of spills, and other site specific factors.*
7. SUMMARY OF RESULTS AND ACTIVITIES

7.1 Summary of Findings

Mercury free alternatives exist for most mercury-bearing products. In fact, cost does not appear to be a significant barrier to the replacement of mercury products with mercury free alternatives. The use of mercury free products is a cost-effective choice when the direct and indirect costs of the products are considered. It is difficult to compare mercury and non-mercury equipment on the basis of purchase price alone since no two pieces of equipment are identical; and there are many factors that hospitals need to consider in their purchasing specifications including: safety, ease of use, efficacy, warranty, time savings, and preferences of medical staff.

On the basis of purchase price alone, the cost of mercury free equipment is generally slightly higher than mercury-based products. However, when other direct and indirect costs are considered, mercury free equipment was found to be cost effective for hospitals. Direct costs to hospitals include not only purchase price but also costs associated with clean-up of spills, training, storage, disposal, as well as potential non-compliance risks to the hospital and potential health risks to staff, patients, and visitors. Indirect environmental and health costs to the general public and wildlife may also be significant. Moreover, it is important to note that product cost is not the most important factor when patient care decisions are being made.

Costs for lab chemicals and pharmaceuticals are difficult to compare directly since these chemicals are not used in isolation but as part of a protocol or procedure. Hospitals in the United States that have replaced their lab chemicals found that costs for using mercury free alternatives were approximately the same. For lab and pharmaceutical chemicals, purchase price is not considered to be an issue when exploring alternatives, but rather getting hospital staff to alter their practices. Therefore, the key issue in replacing mercury containing chemicals and pharmaceuticals is increased awareness and education of staff, management, and suppliers.
7.2 Examples of Phase-out Activities

The following are examples of some mercury phase-out initiatives by Ontario hospitals:

1. Hospital for Sick Children has reduced their use of mercury containing thermometers, sphygmomanometers, weighted esophageal dilators, mercury switches, and old microwave ovens; and have phased out their use of defibrillators. The facility is undergoing a lighting retrofit program to use more energy efficient lamps which contain less mercury and have the added benefit of reducing mercury releases to the environment caused by the burning of fossil fuels to produce electricity.

2. Centenary Health Centre is in the process of reducing their use of mercury batteries, nursing incubator thermometers, old microwaves, and electric mercury relays. The hospital is also undergoing a lighting retrofit program to use more energy efficient lamps.

3. The Toronto Hospital has started a program to reduce mercury containing thermometers and sphygmomanometers, mercury vapour lamps, B5, mercuric chloride, elemental forms of mercury, mercuric thiocyanate, and no longer uses Zenker’s solution.

4. North York Branson Hospital is in the process of phasing out mercury containing sphygmomanometers, nursing incubator thermostats, and Mercury chloride.

5. North York General Hospital has started reducing their use of mercury-containing thermometers and sphygmomanometers, and batteries; as well as completely eliminating the use of their old microwaves.

6. St. Joseph’s Health Centre has started phasing out their use of Thimerosal and nursing incubator thermostats, and have already phased out mercury-containing thermometers.

7. Etobicoke General Hospital is developing an environmental management system (EMS) as part of a pilot study, and are looking into reducing their use of mercury containing products as part of their EMS.

This list is not inclusive and other hospitals may also be undertaking mercury reduction initiatives. During the process of eliminating or reducing mercury in their facility, hospitals sometimes find that cost-savings and procedural savings that were not considered at the time the decision to eliminate the product was made.
7.3 Suggested Steps for Reducing Mercury in Hospitals

The most effective way for hospitals to reduce mercury use in pharmaceuticals and chemicals is to establish a purchasing policy that puts the onus on the supplier/vendor to supply mercury free chemicals (unless there is no viable alternative), rather than having the hospital continually verify their purchases.

There are a number of steps that need to be taken to reduce or eliminate the use of mercury in health care facilities including:

1. Developing broad communications program throughout the facility to increase staff awareness of mercury's adverse effects on human health and the environment.

2. Inventory the facility for mercury products and gradually replace with less harmful, non-toxic substances.

3. Train personnel on spill prevention, management, and methods for preventing pollution, including mercury.

4. Initiate formal administrative directives, especially in purchasing policy, to purchase only mercury free products where viable alternatives exist. Require suppliers to sign an agreement stating that they will supply mercury free products where feasible. State mercury free status in the mission statement of the hospital.

5. Start eliminating mercury where possible, along with an education program, starting with staff, then patients, and finally the public.

6. Ensure that mercury and existing mercury containing products are recycled, or properly treated and disposed of when being replaced.
REFERENCES


Many animals are also affected by mercury. Fish accumulate mercury in their muscle tissue. Animals which rely on fish for a large portion of their diets, such as loons, eagles, mink and osprey are at risk from contaminated fish and may suffer neurological impairment as a result.

**Exposure**

Humans are most likely to be exposed to mercury through the consumption of fish. Exposure can also take place through the ingestion of water and other food sources and through the skin. In some workplaces (such as in a health care setting), there is also a risk of mercury inhalation.

Methylmercury accumulates in the environment and in wildlife, but the highest concentrations appear in the muscle tissue of fish, particularly fish at the top of the aquatic food chain.

Measured values of methylmercury in fish from various areas of the U.S. range from less than 0.1 parts per million (ppm) to 8.94 ppm; typical values are between 0.11 and 0.26 ppm.

**Top 10 types of fish consumed by U.S. residents and their mercury concentrations in micrograms/gram wet weight (parts per million):**

<table>
<thead>
<tr>
<th>Fish</th>
<th>Mercury Concentration (parts per million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuna</td>
<td>0.206</td>
</tr>
<tr>
<td>Shrimp</td>
<td>0.047</td>
</tr>
<tr>
<td>Pollock</td>
<td>0.15</td>
</tr>
<tr>
<td>Salmon</td>
<td>0.035</td>
</tr>
<tr>
<td>Cod</td>
<td>0.121</td>
</tr>
<tr>
<td>Catfish</td>
<td>0.088 &amp; 16</td>
</tr>
<tr>
<td>Clam</td>
<td>0.023</td>
</tr>
<tr>
<td>Flounder</td>
<td>0.092</td>
</tr>
<tr>
<td>Crab</td>
<td>0.117</td>
</tr>
<tr>
<td>Scallop</td>
<td>0.042</td>
</tr>
</tbody>
</table>

Source: MERCURY STUDY REPORT TO CONGRESS, Volume I: Executive Summary, SAB Review draft, USEPA, June 1996.

According to the US EPA, fish consumption advisories for mercury increased 46% from 1993 to 1995 (899 to 1,308). The number of states that have mercury advisories has risen steadily from 27 in 1993 to 37 in 1996. Ten states have issued 90% of the 1,308 mercury advisories in effect: Minnesota, Wisconsin, Florida, North Dakota, Massachusetts, New Jersey, Michigan, New Mexico, South Carolina and Georgia.

Note that about one gram of mercury will contaminate a twenty-acre lake with enough mercury to cause fish advisories. For comparison, a teaspoon of mercury weighs about 70 grams. One thermostat contains about 3 grams of mercury, one electrical switch about 3.5 grams of mercury, and 100 fluorescent lamps contain about 4 grams of mercury.

Elemental mercury can be inhaled easily and is readily absorbed into the bloodstream. This can occur when an item containing elemental mercury (like a thermometer or a sphygmomanometer)


Appendix 1: Ontario Mercury Health Care Steering Committee

<table>
<thead>
<tr>
<th>Name</th>
<th>Baycrest Centre</th>
<th>(416) 785-2500 x2849</th>
<th>(416) 789-2378</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karrin Broadhurst</td>
<td>Broadhurst EMI</td>
<td>(519) 542-7760</td>
<td>(519) 542-7794</td>
</tr>
<tr>
<td>Neil Smith</td>
<td>Centenary Health Centre</td>
<td>(416) 281-7328</td>
<td>(416) 281-3732</td>
</tr>
<tr>
<td>Bob Krauel</td>
<td>Environment Canada</td>
<td>(416) 739-5861</td>
<td>(416) 739-4405</td>
</tr>
<tr>
<td>Edith Hodgson</td>
<td>Etobicoke General</td>
<td>(416) 747-3400 x3417</td>
<td>(416) 747-8608</td>
</tr>
<tr>
<td>Tony Lindop</td>
<td>Gt. Lakes Poll. Prevent. Cent.</td>
<td>(905) 829-0228</td>
<td>(905) 829-1545</td>
</tr>
<tr>
<td>Kevin Vibert</td>
<td>Health Care Envir. Network</td>
<td>(416) 397-0203</td>
<td>(416) 392-4754</td>
</tr>
<tr>
<td>Anne Monteath</td>
<td>Hospital for Sick Children</td>
<td>(416) 813-7583</td>
<td>(416) 813-5219</td>
</tr>
<tr>
<td>Val O'Grady</td>
<td>Hospital for Sick Children</td>
<td>(416) 813-6973</td>
<td>(416) 813-7933</td>
</tr>
<tr>
<td>Ian Smith</td>
<td>Ministry of Environment &amp; Energy</td>
<td>(416) 314-7996</td>
<td>(416) 314-7930</td>
</tr>
<tr>
<td>Sharon Crafter</td>
<td>North York Branson Hospital</td>
<td>(416) 633-9420 x6411</td>
<td>(416) 635-2424</td>
</tr>
<tr>
<td>Doug Shiozaki</td>
<td>Peel Memorial Hospital</td>
<td>(905) 796-4066 x5235</td>
<td>(905) 451-2690</td>
</tr>
<tr>
<td>Bruce Lourie</td>
<td>Pollution Probe</td>
<td>(416) 922-9038</td>
<td>(416) 922-1028</td>
</tr>
<tr>
<td>Cristina Giannetas</td>
<td>Pollution Probe</td>
<td>(416) 922-9038</td>
<td>(416) 922-1028</td>
</tr>
<tr>
<td>Brian Williams</td>
<td>St. Joseph's Health Centre</td>
<td>(416) 530-6079</td>
<td>(416) 530-6372</td>
</tr>
<tr>
<td>John Persaud</td>
<td>The Toronto Hospital</td>
<td>(416) 340-4128</td>
<td>(416) 340-4905</td>
</tr>
</tbody>
</table>
Appendix 2

Mercury Reduction in the Health Care Sector: A Guide to Sources and Alternatives
Mercury Reduction in the Health Care Sector

A Guide to Sources and Alternatives

This guide is designed to assist staff at health care facilities in pollution prevention activities. While the list is by no means exhaustive, this sampling is intended to provide a starting point for hospital staff to assess the presence of mercury in their institution. Additionally, alternatives to mercury-containing products are identified.

A helpful source of information on locating suppliers of alternatives to mercury-containing products is the Canadian Health Association's Buyer's Guide. As well, your hospital's purchasing agent has information on a large variety of vendors and suppliers who sell the products listed in this guide.

Environment Canada does not promote or endorse the suppliers or the alternatives listed in this guide since no environmental assessment was done of those alternatives by the Department. Environment Canada offers this document as a source of information only. It is the responsibility of those seeking alternatives to determine whether a particular product is appropriate for their use.

The author wishes to express sincere appreciation to all those who assisted in the preparation of this guide by generously sharing their time and expertise. Without their help, this guide would not be possible.
### PRODUCTS

<table>
<thead>
<tr>
<th>Product</th>
<th>Location/Use</th>
<th>Available Alternatives</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amalgam</td>
<td>Dentistry</td>
<td>Gold, ceramics, porcelain, polymers</td>
<td></td>
</tr>
<tr>
<td>Batteries (Mercury oxide)</td>
<td>Oxygen monitors, ECG monitors, personnel pagers, defibrillators, hearing aids, pacemakers, fetal monitors, etc.</td>
<td>Lithium, Zinc air, alkaline batteries</td>
<td></td>
</tr>
<tr>
<td>Cantor tube</td>
<td>Gastrointestinal device</td>
<td>Anderson tube</td>
<td>Device not widely used.</td>
</tr>
<tr>
<td>Colometric chloride analysis</td>
<td>Chemistry</td>
<td>Ion-selective electrode method</td>
<td></td>
</tr>
<tr>
<td>Weighted esophageal dilator (Maloney or Hurst bougie)</td>
<td>Operating Room</td>
<td>Mercury-free versions are now available with Tungsten or stainless steel as a weight.</td>
<td></td>
</tr>
<tr>
<td>Weighted feeding tubes (old)</td>
<td>Patient Care</td>
<td>Virtually all new weighted feeding tubes use Tungsten, instead of mercury, as a weight.</td>
<td></td>
</tr>
</tbody>
</table>

### Instruments

<table>
<thead>
<tr>
<th>Product</th>
<th>Location/Use</th>
<th>Available Alternatives</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursing Incubator thermostat</td>
<td>Nursery</td>
<td>Virtually all new nursing incubator thermostats now contain alcohol, rather than mercury.</td>
<td>The amount of mercury in fluorescent lamps has decreased significantly in the past decade.</td>
</tr>
<tr>
<td>Lamps: Fluorescent, High Intensity Discharge, High pressure sodium, Ultraviolet</td>
<td>Variety of Areas</td>
<td>Use the most long-lasting, energy-efficient lights available for your intended use.</td>
<td></td>
</tr>
<tr>
<td>Microwave oven (old)</td>
<td>Various areas</td>
<td>Use new models</td>
<td>Heat is generated through mercury vapour bulb.</td>
</tr>
<tr>
<td>Miller-Abbott tube</td>
<td>Gastrointestinal device</td>
<td>Tungsten tubing as a weight</td>
<td>Device not widely used.</td>
</tr>
<tr>
<td>Otoscope (old)</td>
<td>Emergency Room</td>
<td>New models do not contain mercury switches</td>
<td></td>
</tr>
<tr>
<td>Sequential Multiple Analyser (SMAC)</td>
<td>Chemistry</td>
<td>Ion selective electrode</td>
<td>SMAC not widely used.</td>
</tr>
<tr>
<td>Sphygmomanometer</td>
<td>Patient Care, measures blood pressure</td>
<td>Aneroid</td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>Location/Use</td>
<td>Available Alternatives</td>
<td>Remarks</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hematoxylin</td>
<td>Microbiology, Histology stain solution</td>
<td>Sodium Iodate&lt;br&gt;Gill's Hematoxylin&lt;br&gt;Mercury-free Hematoxylin (mercuric oxide-free)</td>
<td>Mercuric oxide is used in the preparation of some types of hematoxylin staining solutions.</td>
</tr>
<tr>
<td>Immune saline</td>
<td>Blood bank saline</td>
<td>Thimerosal-free immune saline</td>
<td>Some immune salines contain the preservative thimerosal.</td>
</tr>
<tr>
<td>Mercuric chloride</td>
<td>Microbiology test reagent</td>
<td>Nitric acid</td>
<td>Product not currently widely used independently, is the main ingredient in the histological fixative B5.</td>
</tr>
<tr>
<td>Mercuric iodide</td>
<td>Histology stain</td>
<td>Phenate method</td>
<td></td>
</tr>
<tr>
<td>Mercuric nitrate</td>
<td>Chemistry, method used for the determination of chlorides in blood</td>
<td>See Remarks</td>
<td>Product not currently widely used.</td>
</tr>
<tr>
<td>Neosporin</td>
<td>Patient Care, used for the treatment of cuts</td>
<td>Neosporin&lt;br&gt;Mycin</td>
<td></td>
</tr>
<tr>
<td>Phenolic Mercuric Acetate</td>
<td>Chemistry</td>
<td>Ion selective electrode</td>
<td>Reagent not widely used.</td>
</tr>
<tr>
<td>Thimerosal (common name) or Merthiolate</td>
<td>Various Areas</td>
<td>Thimerosal-free products, where available</td>
<td>As a preservative, thimerosal is often found in pharmaceuticals and optical solutions. As well, thimerosal can be used as a bactericide.</td>
</tr>
<tr>
<td>Product</td>
<td>Location/Use</td>
<td>Available Alternatives</td>
<td>Remarks</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mercury switches</td>
<td>Various Areas</td>
<td>Bi-metallic strips or electronic strips</td>
<td>Switches contain trace amounts of mercury.</td>
</tr>
<tr>
<td>Thermometer</td>
<td>Patient Care, Emergency Room</td>
<td>Electronic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic sensors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gallitan (mixture of gallium, indium, &amp; tin)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temperature strips</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tympanic/Infrared aural</td>
<td></td>
</tr>
<tr>
<td>Thermometer</td>
<td>Laboratories (water baths, lab</td>
<td>Alcohol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ovens, refrigerators, incubators)</td>
<td>Electronic</td>
<td></td>
</tr>
<tr>
<td>Vacuum systems (may use</td>
<td>Maintenance</td>
<td>Eliminate where possible, protect from</td>
<td></td>
</tr>
<tr>
<td>mercury-containing</td>
<td></td>
<td>breakage and spills.</td>
<td></td>
</tr>
<tr>
<td>manometers)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Chemicals**

<table>
<thead>
<tr>
<th>Product</th>
<th>Location/Use</th>
<th>Available Alternatives</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>B5</td>
<td>Cytopathology, Histology stain</td>
<td>Zinc formalin such as Z-Fix</td>
<td>After using B5, all solutions (such as rinsate, alcohols, etc.) can be contaminated with mercury. Proper disposal methods must be practiced.</td>
</tr>
<tr>
<td>Carbol-fuchin</td>
<td>Microbiology, Histology stain</td>
<td>See Remarks</td>
<td>The commonly used preparations of Carbol-fuchin do not contain mercury.</td>
</tr>
<tr>
<td>Iodine solution</td>
<td>Microbiology, Histology stain solution</td>
<td>See Remarks</td>
<td>While an iodine solution itself does not contain mercury, trace amount may be present as a result of its use after Zenker's or B5 Solution was used or the presence of a preservative.</td>
</tr>
<tr>
<td>Product</td>
<td>Location/Use</td>
<td>Available Alternatives</td>
<td>Remarks</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>--------------------------</td>
<td>------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Zenker's solution/Lilly's buffered (contains</td>
<td>Pathology, Histology,</td>
<td>Zinc formalin</td>
<td>After using Zenker's solutions are contaminated with mercury (such as</td>
</tr>
<tr>
<td>Mercuric chloride)</td>
<td>Necropsy</td>
<td></td>
<td>rins and alcohols). Proper disposal methods must be practiced.</td>
</tr>
</tbody>
</table>

Notes:

It is often difficult to determine precisely whether mercury is present in a particular chemical. Material Safety Data Sheet (MSDS), for example, are not required to list hazardous components in a product unless that component is present at a level of 1% or greater (0.1% for carcinogens). Consequently, a particular product could contain up to 10,000 parts per million mercury before the manufacturer would have to alert the users of that fact. As well, some manufacturers are reluctant to divulge ingredients in their products because of patent concerns.

Some hospitals that have implemented comprehensive mercury reduction programs have recorded chemicals disposed down drains and assayed drains in order to determine chemicals containing mercury. Thimerosal or merthiolate, a preservative and bactericide, is present in many products ranging from lab chemicals to optical solutions and pharmaceuticals, but not always listed as an ingredient. In this case, it may be necessary to contact the manufacturer of product in question to confirm its ingredients.

DISPOSAL OF MERCURY-CONTAINING PRODUCTS

Because of their toxicity to humans and the natural environment, mercury-containing products must be carefully managed. Most cases, mercury-containing products from hospitals can either be safely disposed of or recycled. For advice on disposal of your hospital's mercury-containing products, contact your current biomedical or hazardous waste hauler. For a list of companies that dispose of and/or recycle mercury, contact the Ontario Waste Exchange at (905) 822-4111, extension 656, fax (905) 822-7630.

SOME SUPPLIERS OF ALTERNATIVE PRODUCTS

Sherwood-Davis & Geck
151 Whitehall Drive
Markham, ON
L3R 9T1
phone: (905) 479-5500
fax: (905) 479-5602

Welch Allyn Canada Limited
160 Matheson Blvd. E.
Mississauga, ON
L4Z 1V4
phone: (905) 890-0004
toll free: 1-800-561-8797
fax: (905) 890-0008

Hoffmann-La Roche Limited
2100 Syntax Court
Mississauga, ON
L5N 3X4
phone: (905) 821-4000
fax: (905) 821-7548

Ingram & Bell
20 Bond Avenue
Don Mills, ON
M3B 1L9
phone: (416) 444-7381
fax: (416) 444-3894

Electronic and tympanic
thermometers

Aneroid blood pressure units,
infrared aural thermometers,
electronic thermometers

Mercury-free pharmaceuticals,
diagnostic reagents and
affiliated products

Mercury-free thermometers
and sphygmomanometers;
stainless steel weighted
esophageal bougies

Smith, David. Personal Communications. October 4 and October 16, 1996a. Former Division Director, Support Services, Riverside Osteopathic Hospital, Michigan.


SOURCES CONSULTED

