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Mercury Spills: A Public Health Concern

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1. Abstract

Mercury is a silvery, odourless, highly volatile, metallic element, which is in liquid form at room temperature. If ingested, mercury is highly toxic to health. Mercury exposure from occupational, environmental and contaminated food is a significant threat to public health. A number of health products do involve mercury, such as sphygmomanometers, thermometers, GIT devices and dental amalgams. Being handled in a number of equipments, accidental mercury spills are not uncommon. In the Hazardous Substances Emergency Events Surveillance program (HSEESP) conducted in USA, mercury spills have been reported to be the 3rd most common incident. Exposure to mercury affects the skin, kidney, nervous system, and the respiratory system. Specific signs of mercury poisoning include emotional instability, cognitive and memory loss, speech problems, and ataxia. Preventive aspects include barring the use of mercury based equipments and usage of alternative devices.

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2. Keywords

Mercury Toxicity; Dental amalgam; Spill; Spill management.

3. Introduction

Mercury is a silvery, odourless, highly volatile and the only common liquid metal. Its usefulness stems from its unique combination of weight, ability to flow, electrical conductivity, chemical stability, high boiling point and relatively low vapour pressure [1]. Mercury is one of the most toxic natural elements, is found in sources such as rock formations and volcanoes. Over the past century, anthropogenic sources of mercury have increased dramatically. It has been estimated that the amount of mercury entering the environment has increased manifold due to a wide variety of human activities, ranging from coal-burning power plants and waste incinerators to common consumer products [2].

In chemicals, including pharmaceutical, mercury is also being used as a preservative. In addition to above, mercury-containing devices and materials have been an integral part of Health Care Facility operations for decades, for many other applications [1]. Currently, there is a worldwide trend to rule out the use of mercury from human activities. The occupational risk of mercury to medical personnel (including a major proportion of dentists) has been observed to be high [3]. This risk depends on the update of the techniques for healthcare activities and these risks can be minimized by performing modern practices for complying with standards handling of hazardous substances [2].

3.1. Mercury Use in Health-care Things

Mercury is used in many different ways in healthcare industry, viz. common measuring devices: sphygmomanometers (blood pressure devices), thermometers (specifically body temperature thermometers but also others) and a number of gastro-intestinal devices, such as cantor tubes, esophageal dilators (bougie tubes), feeding tubes and Miller Abbott tubes [4].

3.2. Mercury use in dentistry

One of the major concern with mercury, is its usage in amalgam restorations, and some observers have contended that exposure to

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mercury from dental amalgam often exceeds the sum of exposure from all other sources, though no evidence has been reported on any ill effects from the amount of mercury released by dental amalgams [5,6].

4. Toxic Effects Of Mercury

Mercury exposure from occupational, environmental, dental amalgam, and contaminated food exposure is a significant threat to public health [7]. According to WHO, human mercury exposures occur chiefly through inhalation of elemental mercury vapour via occupational or dental amalgam exposure or through ingestion of mercury bonded to organic moieties (methyl, dimethyl, or ethyl mercury), primarily from seafood. A less common source of mercury vapour is spilled mercury [8, 9].

Approximately 80% of mercury absorbed in our body is through inhalation, compared to about 7 to 10% absorption of ingested mercury, and about 1% absorption of mercury is through skin contact. On entry to the body, mercury has great affinity for sulfhydryl groups and bonds to sulfur-containing containing amino acids throughout the body [10]. Metallic mercury passes easily through the blood brain barrier and through the placenta, where it lodges in the foetal brain. Mercury deposits readily in foetal tissues and is found in breast milk [11, 12].

The chief target organ of mercury vapour is the brain, but impairment of peripheral nerve function, renal function, immune function, endocrine and muscle function is also reported. With massive acute exposure to mercury vapour, erosive bronchitis and bronchiolitis leading to respiratory failure may be accompanied by CNS symptoms such as tremor or erethism [13]. Exposures to 1-3 mg/m^3 mercury trigger clinical CNS effects [14].

There have been reports of mass acute mercury toxicity in the past. In Minamata, Japan, in 1953, neurologic manifestations were reported in villagers who had eaten methylmercury contaminated fish and shellfish. Between 1953 and 1971, cerebral palsy, seizures, and mental retardation were seen in the children of exposed mothers. In 1964, an epidemic occurred in Niigata, Japan. The source of mercury was traced to ingestion of fish contaminated by mercury from industrial discharge. In 1971, a widespread epidemic with similar symptoms occurred in Iraq, where the source was barley and wheat grain treated with mercury [15].

Chronic exposure to clinically significant doses of mercury vapour usually produces neurological dysfunction. At low-level exposures, nonspecific symptoms like weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbance have been reported [16]. Higher exposure levels are associated with mercurial tremor: fine muscle fasciculations punctuated every few minutes by coarse shaking. Erethism may also be observed: severe behaviour and personality changes, emotional excitability, loss of memory, insomnia, depression, fatigue, and in severe cases delirium and hallucination [17]. Gingivitis and copious salivation have also been commonly noticed [18].

Mercury is believed to interfere with DNA transcription and protein synthesis, including protein synthesis in the developing brain, with destruction of endoplasmic reticulum and ribosomes. The inorganic salts of mercury are corrosive to the skin, eyes and gastrointestinal tract, and may induce kidney toxicity if ingested [19].

Among dentists, certain subtle clinical findings have been documented, including delayed reaction time, poor fine motor control, and deficits in mental concentration, vocabulary, task switching, as well as mood lability. Evidence also links elemental mercury to depression, excessive anger, and anxiety, as well as acute myocardial infarction, lipid peroxidation, and carotid atherosclerosis [20].

4.1. The Diagnostic Dilemma of Testing Mercury Toxicity

It is important to note that prior to beginning any detoxification protocol one should perform a chemistry profile to test for kidney and liver function. Mercury, once it is released into the body, is quickly bound to the nervous system. Except for a short period after acute exposure, mercury's rapid transport to the nervous tissue dramatically limits its presence in the blood, hair, urine, faeces, sweat or any other body fluids. Therefore, a regular trace-element analysis of hair, whole blood, or red cell will generally not show any evidence of mercury toxicity unless the patient is actively detoxifying mercury [21].

Thus, even after presence of extensive clinical manifestations, diagnosis of mercury toxicity is difficult. The commonly used modalities (blood, urine, and/or hair levels) do not usually correlate with total body exposure and are of little diagnostic information. There are currently no consensus criteria for the diagnosis of mercury overload, or for overload of other toxic metals [20].

5. Exposure Limit for Mercury Spills

WHO recommendations for mercury contamination and exposures are as follows:

- Water: 1 μg/litre for total mercury [27]
- Air: 1 $\mu g/m^3$(annual average) [28]

- WHO estimated a tolerable concentration of 0.2 μg/$m^3$for long-term inhalation exposure to elemental mercury vapour [29]

- A tolerable intake of total mercury of 2 μg/kg bodyweight per day [29]

Table 1: Alternatives to Some Mercury Based Medical Instruments [1]

Product	Application	Alternatives
Dental Amalgams	Tooth Restoration	Dental Amalgams capsule, restorations by Gold, Ceramic, Wrought Alloys, Composites, Glass Ionomers etc.
Thermometers	Measurement of Body Temperature	Digital, Expansion, Aneroid, Single-use thermometers, thermometers containing Gallium, Indium etc.
Manometers	Measurement of Blood Pressure	Non-Mercury liquid, needle bourdon gauges, digital and aneroid manometers.
Spygmomanometers	Measurement of Blood Pressure	Electronic Vaccum gauge, expansion, aneroid
Surgical – esophageal dilators	-	Silicone filled dilator, tungsten filled dilator
Pharmaceuticals (traditional medicine)	Some vaccines and eye drops (mainly as a preservative)	Mercury-free chemicals such as 2-phenoxy-ethanol as a preservative.
Mercuric Chloride	Fixative	Zinc Chloride

6. Mercury Spills

Being handled in a number of equipments and owing to a wide application, accidental mercury spills are not uncommon. These are mostly due to mishandling or improper storage of old natural gas regulators, manometers, sphygmomanometers, thermometers, and thermostats [22]. Zeitz in 2002 reported that nearly 96% of the spills in 14 states of US were due to improper handling and 4% spills were transport related[(23)]. Mercury ranks third among hazardous substances incidents that were reported in USA by the Hazardous Substances Emergency Events Surveillance program (HSEESP) from 2000 to 2005. Two thirds of reported mercury spills (67%) were caused by human error and more than a quarter (26%) were due to equipment failure (mercury spill incidents) [24].

Medical personnel, Nurses and other healthcare staff work with mercury-based products on a routine basis and are in danger of inhaling toxic vapour when breakages or leakages occur. Among Dental personnel, exposure to mercury potentially can be from various sources apart from accidental spills, such as freshly mixed dental amalgam, malfunctioning amalgamators, leaky amalgam capsules, trituration, vaporization of mercury from contaminated instruments; and open storage of amalgam scrap or used capsules [25].

Small spills of mercury (for example, the amount in a fever thermometer) on a smooth, non porous surface can be cleaned up safely and easily with proper techniques. However, large beads of mercury are heavy and readily sink into cracked floors or other open surfaces. Mercury can be tracked beyond the original spill area on footwear or on pets' feet. Mercury also clings to porous materials like fabric, carpet or wood, making it difficult to remove [26]. Mercury spill cleanup thus must be thorough and complete.

Inadequate mercury cleaning may lead to long-term exposure from residual droplets or beads. Inadequate cleaning can also increase contamination and cleanup costs. Increased costs can result from replacement of contaminated belongings and from living expenses incurred while the contaminated space is unavailable [24]. Mercury spills that happen indoors where people typically spend long periods of time (such as homes or schools) can be very disruptive and present relocation issues.

After spillage, inhalation is the main source of concern as 80% of inhaled mercury is absorbed. The amount of mercury spilled is directly proportional to the overall presence in the surrounding environment [22].Management of mercury spills follows universal guidelines framed and tested over time. Different constituencies have recommended almost similar measures that can be implemented for healthcare and safety.

6.1. Managing Small Mercury Spills

In the incidents of small mercury spills, such as after a broken thermometer incident, when measured by a mercury vapour analyzer, the maximum mercury airborne concentration has never been more than 1 μg/m^3, even when the room temperature is high [22]. Therefore, even a small quantity of mercury can lead to mercury poisoning, particularly in children where the tolerable dose limits are much smaller. It is advisable that healthcare institutions should phase out mercury devices where safer alternatives are available. Mercury equipment should not be sent home with patients under any circumstance as it increases the risk of mercury contamination in a less controlled environment [26]. Implementing safe management procedures for mercury can substantially reduce the risk of unnecessary exposure [30] :

1. Isolation of the spill area.

2. It is advised to wear nitrile gloves. Covering shoes with disposable covers is also recommended.

3. Any broken pieces of glass or sharp materials should be picked and placed on a paper towel which is to be finally folded and placed in a sealable bag. Secure the bag and label accordingly.

4. The mercury cleanup is initiated by consolidating large droplets using an index card or firm piece of paper. To maintain

control, slow sweeping motions should be used. The larger globules should be carefully collected into a dustpan or stiff piece of paper.

5. A capillary or transfer pipette can be used to aid in the collection of smaller droplets.

6. Collected droplets should be placed onto a damp paper towel to be finally folded and placed in a sealable bag. Secure the bag and label accordingly.

7. There are available Mercury Spill Kits (MSKs) which include powder and sponges that can aid in clean up. These materials can be used to amalgamate the mercury – and are good to use in hard to reach places, surfaces and in cracks.

8. If a mercury spill kit is used, sprinkle the control powder on the mercury and add a small amount of water. The resulting amalgam should make it easier to collect. The collected material to be disposed as mercury containing hazardous waste.

9. Once all visible material has been collected, turn off the lights and scan the floor (parallel to the floor) with a flashlight. Look for any glistening material and use pipettes or spill kit sponges to collect any additional mercury.

10. Linoleum, solid floors, slate or other solid countertop surfaces are fairly easy to clean. Spills on carpet or upholstery cannot be cleaned and should be properly disposed of once contaminated. The effected portion can be cut out for hazardous material disposal.

11. All "clean up" materials should be collected in a plastic bag or container and disposes of as hazardous waste.

There are some precautions to be considered while managing small mercury spills [30]:

- Do not use a common vacuum cleaner because it will blow mercury vapour into the air. Any contaminated vacuum cleaner must be disposed as hazardous waste.

- Do not use a broom. It will cause beads to break up and will spread them over a greater area.

- Do not pour mercury down any drain. Mercury can damage plumbing and is a water pollutant.

- Do not place mercury contaminated items in a washing machine. It can contaminate the machine and pollute sewage.

- Do not walk around areas where mercury has spilled. Shoes may become contaminated and then can be spread throughout areas from those shoes.

6.2. Managing Large Mercury Spills

WHO conservatively classifies anything larger than a broken fever thermometer or thermostat as a large spill. In the case of a large mercury spill, measures to reduce the spread of contamination are vital. However, healthcare staff should not attempt to clean up a large spill. Instead, a professional hazardous waste cleanup company should be contacted. After a large spill, it is recommended that family members should leave their home, particularly if young children or pregnant women are present, and refer the family to an occupational physician familiar with mercury poisoning to monitor exposure [31].

The extent and cost of mercury spill cleanup often depends more on the spread of contamination than on the actual amount spilled.

The residences potentially contaminated with mercury are pre-screened by the environmental safety personnel by a mercury vapour analyzer (MVA), or any air sampling equipment. If initial pre-screening air sampling using a MVA detects concentrations greater than 0.01 mg/m^3 (or 10 $\mu g/m^3$) throughout the residence, individuals should immediately inform that temporary relocation of the residents must be considered. Before relocation, screening of clothing of the family members should be done and, if contaminated, should be changed.

In cases of large spills, all visible mercury is removed using an approved mercury-specific vacuum, and the area should be washed by mercury vapour suppression solution for residual mercury. With the area secured (windows closed and air conditioning turned off), heat the area from 80 to 90°F for 4 hours and ventilate safely for at least 1 hour. Clothing and furnishings may be placed on plastic sheeting in the sun and heated to volatilize the mercury vapours for at least 4 hours [32].

7. Preventing Mercury Spills

The best way to prevent spills is to keep mercury out of the home, school, or workplace. It is advisable that mercury should no longer be used for blood pressure and other medical devices, barometers, manometers, thermometers, or thermostats. These devices should preferably be replaced with mercury-free alternatives, which are just as accurate and similar in cost [33, 34]. Health care workers, the public, and school personnel should be educated about the hazards of mercury, the availability of alternatives, and the cost of mercury cleanup.

8. Indian Government Initiatives Over Mercury Use

India is the world's biggest importer of heavy-metal mercury. As the industrialized world is phasing out mercury, India seems to

be phasing in this toxic metal. In 2003-05, India imported 371 tonnes of mercury [36]. Though with time, India has realized the toxic potential and has enlisted mercury in its list of 29 hazardous wastes according to Indian rules, but the major gap lies in handling and unattended disposal.

Owing to the potential health hazards of mercury, Govt of India included mercury handling in Environment (Protection) Rules, 1986 [37]. In 2005, the Central Pollution Control Board (CPCB) wrote to all the State Pollution Control Boards to stress on the segregation of mercury containing waste and make it a parameter for granting authorization to the healthcare centres. Guidelines have been issued by DGHS in March, 2010 and are being included in Indian Public Health Standards [38].

Under the National Rural Health Mission (NRHM), (2007), an 'Infection Management and Environment Plan (IMEP)' was released [39]. This document has two volumes:

a. A policy framework document, which gives a broad overview and guidance to central and state level institutions on the type of systems and processes to be established for infection control and bio-medical waste management.

b. A set of operational guidelines which are designed as instruction manuals for healthcare workers at primary level healthcare facilities.

Both these volumes integrated mercury spill management and also advised the healthcare establishments to eventually start a phase-out plan for mercury containing equipment.

8.1. Delhi Govt Initiatives Over Mercury Use

Department of Health and Family Welfare, Government of NCT of Delhi framed a 'Mercury Phase-Out Committee' (2007), to look into the use and reduction possibilities of this heavy metal in healthcare. The department drafted and circulated a written policy to all the government hospitals, which asked the hospitals to curb the use of mercury equipment.

Delhi Pollution Control Committee (DPCC) issued a public notice in May 2008 [40], stating that usage of mercury is problematic and the hospitals should initiate steps to stop its use. All hospitals were directed to provide a template on its commitment to minimise/ eliminate mercury containing waste, and the declaration needed to be signed and placed at prominent locations in the corresponding institutes.

Another effort, the Centre for Occupation and Environmental Health (COEH), located at the Maulana Azad Medical College is headed by Dr. T.K. Joshi [41]. The Centre presented various data on the hazards of mercury and dangers to health care staff from the occupational health perspective. COEH has conducted health assessments for healthcare workers in the Delhi government hospitals to assess occupational exposure to mercury. Today, many government hospitals in Delhi have stopped procurement of mercury containing equipments.

8.2. International Collaborations Over Restricting Mercury Use

In 1991, the World Health Organization (WHO) confirmed that mercury contained in dental amalgam is the greatest source of mercury vapor in non-industrialized settings, exposing the concerned population to mercury levels significantly exceeding those set for food and for air [42].

The WHO is following these strategic steps for an eventually mercury-free health care:

- **Short term:** Develop and implement plans to reduce the use of mercury equipment and replace it with mercury-free alternatives. It addresses clean-up, storage, and disposal of mercury.

- **Medium term:** Increase efforts to reduce the use of unnecessary mercury equipment in hospitals. Hospitals should have an inventory of their use of mercury. This inventory should be categorized into immediately replaceable and gradually replaceable.

- **Long term:** Support a ban of mercury-containing devices and promote alternatives. Support countries in developing a national guidance manual for sound management of health care mercury waste. Support countries in the development and implementation of a national plan, policies, and legislation on mercury health care waste. Support the allocation of human and financial resources to ensure procurement of mercury-free alternatives [42].

In 2001, governments requested United Nations Environment Program (UNEP) to produce a global study on mercury. The Global Mercury Assessment Report was published in December 2002, and was presented to UNEP's Governing Council in 2003. The Governing Council considered the assessment at its 22nd session in February 2003, and [35]:

- Concluded that there was sufficient evidence of significant adverse global impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment.

- Decided that national, regional and global actions, both immediate and long-term, should be initiated as soon as possible.

- Urged all countries to adopt goals and take national actions, as appropriate, with the objective of identifying exposed populations and ecosystems, and reducing anthropogenic mercury releases that impact human health and the environment.

- Requested UNEP to initiate technical assistance and capacity building activities to support the efforts of countries to take action regarding mercury pollution.

8.3. WHO (World Health Organization) Recommendations:

National, regional and global actions, both immediate and long-term, are needed to reduce or eliminate releases of mercury and its compounds to the environment. WHO is committed to work with the health sector and national, regional and global health partners to [35]:

- Reduce mercury exposure;

- Eliminate the use of mercury wherever possible; and

- Promote the development of alternatives to the use of mercury.

9. Conclusion

Owing to the toxic aspects of mercury, the best way to prevent mercury spills is to avoid its usage. Becausemercury spills may cause hazardous effects, and may pollute the environment, it is not advisable to undertake the cleanup without knowledge. Such cleanups, if not associated with small spills, are best done by hazardous waste firms that are qualified to perform this work. To reduce the chances of a spill occurring, alternatives to Mercury-containing devices (e.g., thermometers, barometers, manometers, and blood pressure and other medical devices) should be used. Such devices are widely available and comparable in cost and work equally well. The adoption of these recommendations should be informed to the public. People need to be educated about the hazards of Mercury, the costs of cleaning it up, and the availability of Mercury-free products for a safeguarded health-care practice.

References

1. Babu JC. Environmentally Sound Management of Mercury Waste in Health Care Facilities. Draft Report by Central Pollution Control Board (Ministry of Environment & Forest). Sep 2010.

2. Agrawal A. Moving Towards Mercury-Free Health Care: Substituting Mercury-Based Medical Devices in India. Draft Report by Toxics Link. 2009.

3. Morales FI, Reyes GR. Mercury and health in the dental practice. Rev Saude Publica. 2003; 37(2): 266 - 272.

4. Mercury Awareness Raising Package. A Draft Report. Accessed on 20 Feb, 2013.

5. MacEntee MI, Mojon P. Issues in the amalgam debate. J Can Dent Assoc. 1991; 57: 931- 936.

6. Bjorkman L, Pedersen NL, Lichtenstein P. Physical and mental health related to dental amalgam fillings in Swedish twins. Community Dent Oral Epidemiol. 1996; 24: 260 - 267.

7. International Chemical Safety Cards 0056, 0978, 0979, 0980, 0981 and 0984. Geneva, World Health Organization, International Programme on Chemical Safety. IPCS 2000.

8. World Health Organization. Inorganic mercury: environmental health criteria 118, in International Programme on Chemical Safety. World Health Organization, Geneva, Switzerland. 1991.

9. Richardson M. The Safety of Dental Amalgam. Ministry of Health, Canada. 1996.

10. Eggleston DW, Nylander M. Correlation of dental amalgam with mercury in brain tissue. J Prosthetic Dent. 1987; 58(6): 704 - 707.

11. Nordberg GF, Serenius F. Distribution of inorganic mercury in the guinea pig brain. Acta Pharmacologica et Toxicologica. 1969; 27(4): 269 - 283.

12. Clarkson TW, Magos L, Greenwood MR. The transport of elemental mercury into fetal tissues. Biol Neonate. 1972; 21(3): 239 - 244.

13. Garnier R, Fuster JM, Conso F. Acute mercury vapour poisoning. Toxicol Europ Res. 1981; 3(2): 77 - 86.

14. Echeverria D. Mercury and Dentists. Occup Environ Med. 2002; 59: 285 - 286.

15. Moienafshari R, Bar-Oz B, Koren G. Occupational Risk to Mercury: What is a safe level? Canadian Family Physician. 1999; 45: 43 - 45.

16. Friberg L, Nordberg GF. Mercury in the Environment, CRC Press, Boca Raton, USA. 1972.

17. Berglund A, Pohl L, Olsson S, Bergman M. Determination of the rate of release of intra-oral mercury vapour from amalgam. J Dent Res. 1988; 67(9): 1235 - 1242.

18. Berlin M, Zalups RK, Fowler BA. Handbook on the Toxicology of Metals. Elsevier, New York, USA. 3rd edition. 2007.

19. Bernhoft RA. Mercury Toxicity and Treatment: A review of the literature. J Environmental Public Health. 2012. Article ID 460508.

20. Echeverria D, Heyer NJ, Martin MD, Naleway CA, Woods JS, Bittner AC. Behavioural effects of low level exposure to Hgamong dentists. Neurotoxicology and Teratology. 1995; 17(2): 161 - 168.

21. Woods JS. Altered porphyrin metabolism as a biomarker of mercury exposure and toxicity. Can J Physiol Pharmacol. 1996; 74(2): 210 - 215.

22. Baughman TA. Elemental Mercury Spills. Environmental Health Perspectives. 2006; 114(2): 147 - 152.

23. Zeitz P, Orr M, Kaye W. Public health consequences of mercury spills: Hazardous Substances Emergency Events Surveillance System, 1993–1998. Environ Health Perspect. 2002; 110: 129 - 132.

24. Mercury Spill Incidents Data and Resources; Hazardous Substance Emergency Events Surveillance (HSEES). New York State Department of Health. Sept 2009.

25. J Am Dent Assoc. Dental mercury hygiene recommendations. ADA council on scientific affairs. 2003; 134: 1498 - 1499.

26. The US Environmental Protection Agency's Clean Up Instructions. Assessed on 22 February, 2013.

27. Guidelines for Drinking-water quality 3rd edition. Geneva, World Health Organization. Accessed on 22 Feb, 2013.2004

28. Air Quality Guidelines for Europe. Copenhagen, World Health Organization Regional Office for Europe. WHO. 2000.

29. Concise International Chemical Assessment Document 50: Elemental mercury and inorganic mercury compounds: human health aspects. Geneva, World Health Organization, International Programme on Chemical Safety. IPCS; 2003.

30. Environment Canada's Cleaning Up Small Mercury Spills. Accessed on 22 Feb, 2013.

31. US EPA Mercury Response Guidebook. Section – 1. July, 2004.

32. A Fact Sheet for Health Professionals - Elemental Mercury. Springfield, IL: Illinois Department of Public Health (IDPH). Accessed on 23 Feb, 2013.2004.

33. Canzanello VJ, Jensen PL, Schwartz GL. Are aneroid sphygmomanometers accurate in hospital and clinic settings? Arch Intern Med. 2001; 161(5):729 - 731.

34. Yarows SA, Qian K. Accuracy of aneroid sphygmomanometers in clinical usage: University of Michigan experience. Blood Press Monit. 2001; 6(2): 101-106.

35. Elemental mercury and inorganic mercury compounds. Accessed on 22 Feb, 2013.

36. Sharma, BK. Environmental Chemistry.. Goel Publishing House, Meerut.2007; 11th Edition.

37. The Environment Protection Rules. Published in the Gazette of India. Accessed on 22 Feb, 2013.1986

38. Kulshrestha S. Presentation on Mercury Free Healthcare. Accessed on 22 Feb, 2013.

39. Infection Management and Environment Plan. Policy framework, March 2007. Accessed on 23 Feb, 2013.

40. Mercury Waste Management in the Health Care Establishments in Delhi. Accessed on 23 Feb, 2013.

41. Centre for Occupational and Environmental Health. Accessed on 23 Feb, 2013.

42. Rustagi N, Singh R. Mercury and Health Care. Indian J Occupational Environmental Med. 2010; 14(2): 45 - 48.