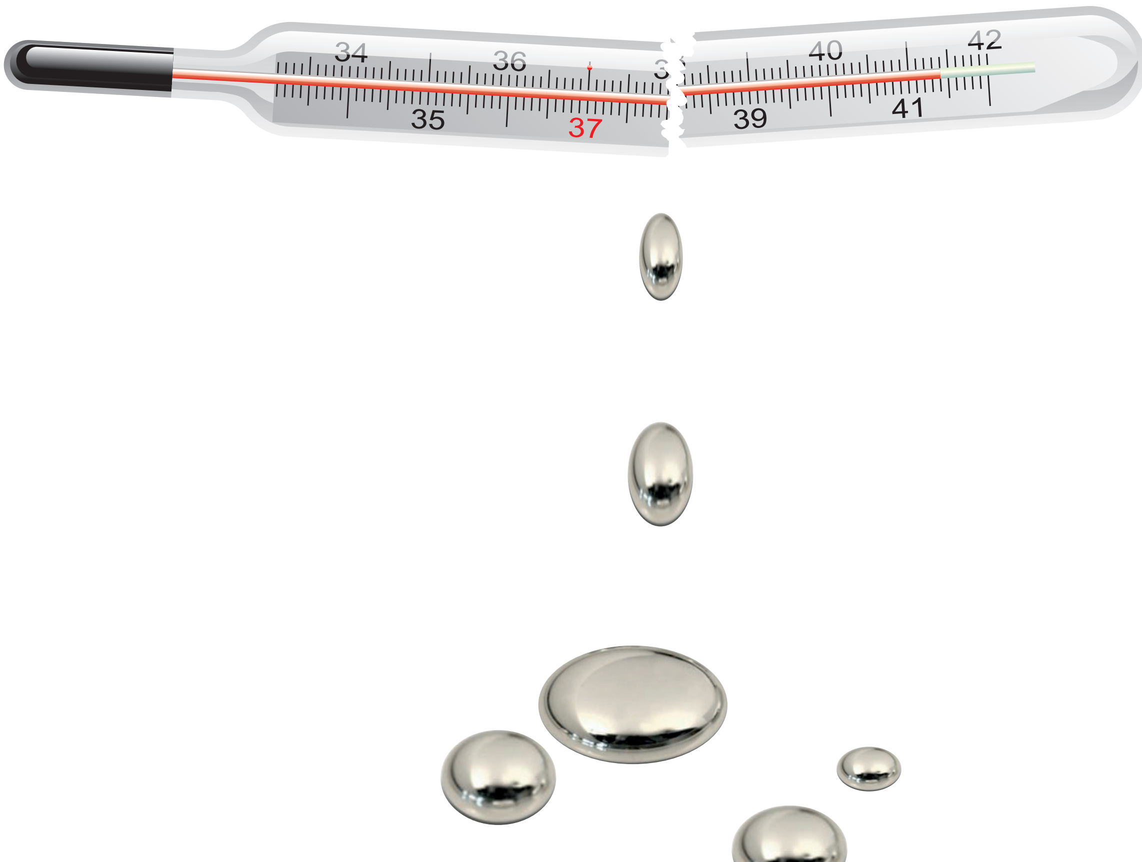
Toxics Link
for a toxics-free world

Estimation of Mercury Usage and Release from Healthcare Instruments in India



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Supported by

zero Hg
mercury working group

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TOXICS LINK

Toxics Link is an environmental organisation, engaged in disseminating information about to help strengthen campaigns against toxic pollution, provide cleaner alternatives and bring together groups and people concerned with, and affected by, this problem.

Toxics Link
for a toxics-free world

"We are a group of people working together for environmental justice and freedom from toxics. We have taken it upon ourselves to collect and share information about the sources and dangers of poisons in our environment and bodies, as well as about clean and sustainable alternatives for India and the rest of the world." This current report was undertaken in the wake of the global phase out of mercury containing healthcare equipment (thermometers and sphygmomanometers). The challenges thrown up in the safe storage of phased out mercury containing healthcare equipment need attention from the concerned stakeholders in the country.

www.toxicslink.org

ZERO MERCURY WORKING GROUP

zero Hg
mercury working group

The Zero Mercury Working Group (ZMWG) is an international coalition of more than 80 public interest environmental and health non-governmental organizations from 42 countries from around the world formed in 2005 by the European Environmental Bureau and the Mercury Policy Project.

ZMWG strives for zero supply, demand, and emissions of mercury from all anthropogenic sources, with the goal of reducing mercury in the global environment to a minimum. Mission is to advocate and support the adoption and implementation of a legally binding instrument which contains mandatory obligations to eliminate where feasible, and otherwise minimize, the global supply and trade of mercury, the global demand for mercury, anthropogenic releases of mercury to the environment, and human and wildlife exposure to mercury.

www.zeromercury.org
Contact: mercury@eeb.org

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Toxics Link

Contents

Executive Summary

Mercury (Hg), a potential contaminant of the environment is of global concern due to its toxic nature, trans-boundary movement and its potential to bioaccumulate and biomagnify.

Fever thermometers and sphygmomanometers are used in all healthcare settings across the globe. Elemental mercury (Hg^0), which is used in these instruments, is in liquid state at room temperature and pressure. There is a high risk of breakage of these instruments leading to the release of Hg, because in both the cases the Hg columns are made of glass.

Medical infrastructure forms the largest portion of the healthcare pie. In the year 2006, ratio of hospital-beds available per thousand populations was 1.03 for India whereas it was 4.3 for countries like China, Korea and Thailand. Though India is far behind in the number of beds available per thousand populations, it is likely to reach a ratio of 1.85 and under the best-case scenario two, by the year 2012.

Healthcare facilities in India have been using Hg thermometers and sphygmomanometers for many years, but some of them have started the process of shifting to Hg free products.

In this report we have estimated the usage of Hg containing thermometers and sphygmomanometer in urban (government and private) and rural healthcare (Community Health Centre, Primary Health Centre and Sub-centre) settings in India taking into account the "Indian Public Health Standards (IPHS)" recommended usage of these products in healthcare facilities. The breakage patterns of these instruments in respective healthcare settings were calculated on the basis of sampling done in five states of India.

India is working towards phasing out Hg containing equipment from the healthcare settings. In an effort to phase out Hg containing products the state government of Delhi (Department of Health) in 2007, issued a directive stopping all future procurement of Hg containing products and directed the health facilities to replace them with Hg free products. In March 2010, the Directorate General of Health Services (DGHS), Government of India issued a guideline addressing the issue of Hg management in healthcare facilities and the need to replace the Hg containing products with non mercury devices. The impact of these guidelines on the usage of these devices can be very significant and need quantification in terms of total quantities of Hg in storage and in use.

India is slowly progressing towards the phase out of Hg based instruments and there is a demand from the medical fraternity for accurate, cost effective alternate technologies and a road map for the final disposal of discarded thermometers and sphygmomanometers. Though standards for digital and aneroid products exist in India, these are still not mandatory. On the contrary, Hg products need a mandatory certification for import and manufacture. Hospitals are keenly looking forward to a stricter standardisation regime for Hg alternates, to increase usage.

Major findings of the report are:

- The total amount of Hg usage in healthcare instruments in India is estimated to be 26 tons.
- The total amount of estimated Hg released through healthcare instruments in India is eight tons; the share of Hg in thermometers and sphygmomanometers is 31 percent and 69 percent respectively. The ratio of Hg contributed by government hospitals as compared to private hospitals is about 10:1.
- The estimated per capita Hg released by medical equipment is approximately 7μg. The estimated Hg used in the healthcare instruments per capita is around 22.54 milligrams.
- As a result of the guideline issued by the DGHS it is expected that there will be a 50 percent reduction in the demand for Hg containing products in the healthcare sector. The Hg stored in healthcare equipment in the country would be reduced from 26 tons to 12 tons.
- In Delhi alone, the amount of Hg stored in these instruments is about 177 kilograms and its ratio in the private healthcare sector to government is almost 1.7 times, which reflects the relative share of private players in healthcare in the metropolis.
- Other than the study itself, this report led to a lot of networking and the capacity building of some grass root level Non Governmental Organisations (NGOs) in the country. The five NGOs who helped and partnered with Toxics Link to carry out the report have been capacitated and are being motivated to work on this issue in their respective geographical areas.

1. Introduction

1.1 Background

Mercury (Hg), a potential contaminant of the environment is of global concern because of its toxic nature, trans-boundary movement and its ability of bioaccumulation etc. The healthcare sector is a key source of mercury's global demand and emissions.

The healthcare sector is one of the most important consumers of elemental mercury (Hg^0), where Hg, is in liquid state especially in instruments like thermometers and sphygmomanometers. These instruments are often at breakage-risk, because in both the cases, the Hg columns are made of glass. Since Hg is liquid at room temperature and pressure, spilled Hg^0, such as, from a broken thermometer, can vaporise into the surrounding air and the concentration is subject to ventilation, temperature etc of the area. Apart from breakage of these instruments, even practices like in-house calibration of Hg-containing sphygmomanometers can be the source of Hg in indoor air. Bad ventilation inside the room or wing can lead to acute exposure to Hg^0, not only to patients, but also to healthcare staff at large.

To understand the situation in Indian healthcare settings, the Toxics Link 2004 study (Agrawal *et al.*, 2004), found that nearly 70 thermometers break each month in a 300 to 500 bedded hospital. Data also shows that an average-sized hospital with a dental wing annually releases three kilograms of Hg in the environment.
Toxics Link (Pastore *et al.*, 2007) already has reported very high concentrations (up to 3.78 μm^{-3}), of Hg^0 in indoor air of two hospitals of Delhi as compared to international standards by The Environmental Protection Agency (EPA), 0.3 μm^{-3}.

1.2 Initiatives in phasing out Hg from healthcare settings

1.2.1 International

To better understand the various aspects of Hg the governments of some countries requested the United Nations Environmental Programme (UNEP) in 2001 to conduct a global study on Hg. The Global Mercury Assessment Report published in December 2002 identified the global nature of problem; state of science, significant sources of mercury releases, and reduction initiatives taken and was presented to UNEP's Governing Council (GC) in 2003. After five years of the Global Mercury Assessment Report, in the year 2007 the GC recognised that efforts to reduce risks from Hg were not sufficient to address the global challenges; rather long-term international action was also needed. So, in February 2009, the UNEP's GC met in Nairobi, Kenya with representatives of 150 governments and agreed to deliberate on a global, legally binding treaty for Hg. The first Intergovernmental Negotiating Committee (INC1) meeting was held in June 2010 at Stockholm, Sweden to prepare a global legally binding instrument on Hg. The GC further agreed to intergovernmental negotiations and the adoption of the treaty at a Diplomatic Conference to be held in 2013.

The World Health Organisation (WHO) in September 2005 issued a policy paper on Mercury in Healthcare, which called for short, medium and long-term steps to achieve the gradual substitution of Hg containing medical equipment. The World Medical Association passed a resolution in 2008 calling for the substitution of Hg based medical devices with safer alternatives. The WHO and Health Care Without Harm (HCWH) are together leading a global partnership since July 2008, aimed at reducing the demand of Hg based medical devices by 70 percent by the year 2017 (Towards the Tipping Point, 2010).

According to UNEP's 2002 Report, developing countries like China followed by India are prime contributors to Hg emission, but there are large uncertainties about these estimates. So, under UNEP's para 29, countries like India, China etc have to make better estimates and inventory of anthropogenic emissions so that the countries' global share can be understood.

The European Union (EU) has banned Hg thermometers for home and healthcare use beginning in 2008. The EU is considering a similar ban on sphygmomanometers (http://www.noharm.org/global/issues/toxins/mercury/policies.php). A country like Sweden has totally banned the use of Hg or equipment containing it in the medical sector.

1.2.2 Indian

The Delhi Pollution Control Committee (DPCC), a body responsible for enforcement of Bio- medical waste (Management & Handling) Rules 1998, subsequent to the report released by Toxics Link (Agrawal *et al.*, 2004) issued its first public notice, about the hazards of mercury and its safe management and recycling. After media reports and Parliament Questions based on the same report, the Central Pollution Control Board (in 2005) initiated action. They wrote to all the State Pollution Control Boards, asking them to stress on the segregation of mercury containing waste and make this a parameter for granting authorization to the healthcare centers.

This was the first step by any central government agency in the country on the issue of mercury. After a sustained campaign with supportive research documents (Agrawal *et al.*, 2004, Pastore *et al.*, 2007) and rigorous follow up by Toxics Link, the Delhi State Government (Department of Health and Family Welfare, Delhi) issued Guidelines to all healthcare facilities to stop the purchase of new Hg based medical devices and replace them with Hg free alternatives in the year 2007 (Agrawal, 2009).

The concerned authorities at the Union Health Ministry noticed the mercury phase out in Delhi. The Directorate General of Health Services (DGHS) of India participated in the International Conference on Heavy Metals on 27th October, 2009, organized by Toxics Link, to understand the integrities of the issue. After the conference they called for a consultative meeting and Toxics Link was asked to share their experiences (national and international) on the issue with all Central Government hospitals in Delhi and senior officials in the Health Ministry. Finally, in March 2010, the DGHS of India issued guidelines at the central government level for the proper management of Hg spills and the gradual phase out of Hg containing equipment with safer alternates.

Delhi Hospitals were asked to phase out mercury-based equipment and submit an affidavit to the government by 30th September 2010. The hospitals were also instructed to inform about the quantity of mercury waste with them.

India is progressing towards the phase out of Hg and there is demand from the medical fraternity for accurate and cost effective alternate technologies. To address the three bottlenecks in the phase out of mercury- cost, standardization and storage, a roundtable meeting was organized by Toxics Link in July 2010.

All important stakeholders were present and the meeting gave a kick start to important discussions on storage and standardisation. Though standards for digital and aneroid products exist in India, they are still not mandatory. On the contrary, Hg products need a mandatory certification for import and manufacture. Hospitals are keenly looking forward to a stricter standardisation regime for Hg alternates, to increase usage. A draft guideline on mercury storage prepared by the CPCB was also discussed in detail.

As the healthcare sector gears up for mercury phase out, there is pressing need to understand the extent and quantum of Hg released/ in use annually in the environment from these instruments, which are commonly used even in homes.

1.3 Objectives and scope of the report

1) To make a detailed inventory of Hg usage in the Indian healthcare sector from instruments (thermometers and sphygmomanometers) so that the storage capacity of the discarded equipment containing Hg can be estimated,
2) To make a detailed inventory of elemental Hg released in the environment by the Indian healthcare sector from instruments (thermometers and sphygmomanometers) so that benefits of the shift can be quantified,
3) To estimate per capita Hg usage so that emissions from healthcare instruments can be better understood,
4) To analyse the impact of the guidelines issued by the Department of Health, Delhi and DGHS, India and
5) To present Delhi's case, where the phase out has to be strictly followed by the year 2011.

2. Mercury usage in the healthcare sector in India

2.1 Healthcare sector in India

Medical infrastructure forms the largest portion of the healthcare pie. In the year 2006, the ratio of hospital-beds available per thousand populations was 1.03 for India whereas it was 4.3 for countries like China, Korea and Thailand. Though India is far behind in the number of beds available per thousand populations it is likely to reach a ratio of 1.85 and under the best-case scenario to two, by the year 2012. The healthcare infrastructure in India is both in the government and private sector. The government healthcare infrastructure in India can be divided based on urbanisation into two sections, rural and urban. The healthcare infrastructure in rural areas in India has been developed as a three-tier system [Community Health Centre (CHC), Primary Health Centre (PHC) and sub-centre] and is based on the population norms (details given in Annexure 1).

Urban hospitals can be divided into two types, a) under the Government of India, and b) private. Further urban-government can be sub-divided into district and sub-district/sub-divisional hospitals. District hospitals can have a bed-strength between 101 to 500 beds or more and sub-district/sub-divisional hospitals can have a bed-strength from 31 to 100.

The provisional list of 3228 private hospitals for the year 2004 was obtained from the cross-reference of the Bureau of Energy Efficiency (BEE) 2009 Report. Presuming an annual growth rate of 12 percent (11th Five Year Plan of Government of India, 2007-2012), the expected increase in the number of private hospitals for the year 2008 works out to 5082.

Table 1: Types of healthcare infrastructure and their respective numbers in the year 2008

	Healthcare infrastructure	No.in year 2008
Rural (Government)	Primary Health Centre (PHC)	23458
	Community Health Centre (CHC)	4276
	Sub-Centre	146036
Urban	District hospitals & sub-divisional hospitals (Government)	3115
	Private	5082[1]

Where, 1: extrapolated number based upon data from Doctors Online (www.hindustanlinks.com, accessed on 21st June 2009.

2.2 The recommended number of thermometers and sphygmomanometers

The National Rural Health Mission (NRHM) was launched in 2005 with the aim of restructuring the healthcare delivery mechanism in India. It was envisaged that the standards of these public institutions would be upgraded from the present form to the level of a set of standards called - "Indian Public Health Standards (IPHS)". IPHS outlines the minimum resources available and mentions the minimum functional level of the institutes in terms of space, building, manpower, equipment etc. Table 2 gives the number of thermometers and sphygmomanometers recommended by IPHS under the respective healthcare settings in India.

2.3 Methodology

2.3.2 Calculation of usage of mercury

Table 1 contains details about the number of government (rural and urban) and private hospitals in year 2008 in India.

$$N_{Hospital} = [N_{rural} + N_{urban}] \quad (1)$$

Table 2: The recommended number of thermometers and sphygmomanometers for respective healthcare settings as per IPHS and values used to estimate mercury (Hg) usage in instruments

Healthcare	Equipment types		IPHS No.	Number used
I. Rural	1. PHC	Sphygmomanometer	1	1
		Thermometer	4	4
	2. CHCs	Sphygmomanometer	1	1
		Thermometer	5	5
	3. Sub-centre	Sphygmomanometer	1	1
		Thermometer	2	2
II. Urban (District hospital)	1. 101-200	Sphygmomanometer	20	30 (average)[1]
		Thermometer	29	
	2. 201-300	Sphygmomanometer	30	
		Thermometer	35	36 (average)[2]
	3. 301-500	Sphygmomanometer	40	
		Thermometer	45	36 (average)[2]

Where, 1: average no. of sphygmomanometers used; 2: average no. of thermometers used
(Sources: DGHS, 2007.
http://mohfw.nic.in/NRHM/Documents/IPHS%20for%20SC.pdf;
http://mohfw.nic.in/NRHM/Documents/IPHS%20for%20CHC.pdf;
http://mohfw.nic.in/NRHM/Documents/IPHS%20for%20PHC.pdf;
http://www.docstoc.com/docs/3904715/Indian-Public-Health-Standards-(IPHS)-for-District-and-Sub)

$$N_{Rural\text{-}Government} = [N_{Subcenter} + N_{PHC} + N_{CHC}] \quad (2)$$

$$N_{urban} = [(N_{Urban\text{-}government}) + (N_{urban\text{-}private})] \quad (3)$$

Where,

$N_{Hospital}$ = Number of hospitals;

N_{rural} = Number of rural hospitals (Government);

N_{urban} = Number of urban hospitals (Private)

Further, the number of thermometers and sphygmomanometers was calculated by multiplying the number of hospitals in the respective categories with the recommended number of thermometers and sphygmomanometers as per the IPHS guidelines (see Table 2).

$$N_{Thermometers} = [\{N_{rural} + N_{urban}\} \times N_{IPHS\ (respective\ categories)}] \quad (4)$$

$$N_{sphygmomanometer} = [\{N_{rural} + N_{urban}\} \times N_{IPHS\ (respective\ categories)}] \quad (5)$$

Where,

$N_{Thermometers}$ = Number of thermometers;

$N_{IPHS\ (respective\ categories)}$ = Recommended number of instruments under IPHS

The average Hg in each thermometer is one gram whereas the amount in sphygmomanometers varies from country to country. The Hg content in each sphygmomanometer in the European Union (EU) varies from 80 grams to 100 grams (WHO, 2005) whereas it is about 60 grams in India (Wankhade, 2003).

Finally, the total amount of Hg (kg) under usage in thermometers and sphygmomanometers was calculated by multiplying the average weight of mercury in each, 0.001 kilogram and 0.06 kilogram respectively.

$$S_{Hg\text{-}Thermometer} = [N_{Thermometers} \times (0.001)] \quad (6)$$

$$S_{Hg\text{-}Sphygmomanometer} = [N_{sphygmomanometer} \times (0.06)] \quad (7)$$

Where,

$S_{Hg\text{-}Thermometer}$: Stored mercury in thermometers (Kg);

$S_{Hg\text{-}Sphygmomanometer}$: Stored mercury in sphygmomanometers (Kg)

2.3.3 Calculation of mercury release

The total amount of Hg (kg) spilled due to equipment breakage was calculated by multiplying the number of hospitals in each category by per bed breakage and the bed strengths under each category of hospitals.

The breakage rates were calculated by analysing sampled values from five states for various healthcare settings (Table 3). The data collection was done by, various partner NGOs in different states of the country. The limited sample size was a major limitation of the present study. In the protocol, a specified number of each type of healthcare setting was supposed to be covered, but due to varied accessibility of data or premises and other reasons, some states were able to manage only PHCs/ Sub Centres/ CHCs/ District Hospitals respectively. Thus for consistency in data we have considered different states for different types of hospitals. For instance, Uttar Pradesh, which has sampled the maximum number of hospitals in the range of above 100 beds, has been taken into account for that range and likewise for other categories.

Urban hospitals in both the government and private sector show the same type of breakage rates and an average of these has been taken into account to work out the breakage in this sector.

Table 3: Breakage pattern of mercury thermometers and sphygmomanometers (/bed/year) in various healthcare settings in India					
Avg. breakage /bed/yr	Urban- Government[a]	PHC	CHC	Sub- centre*	Urban-Private
Bed strength considered	a	5	30	0	b
Thermometers	1.8	1.7	0.26	0.1	1.8
Sphygmomanometers	0.2	0.12	0.1	0.05	0.2

Where, *: per hospital per year, Note: Sub-centres do not have in-patient department (IPD). a, b: details about number of hospitals under respective bed-strength window, given in Annexure 3.

The differential hospital number in the urban sector in both the private and government sectors has been worked out taking into account the Delhi model. The extrapolation of the total number of hospitals in India (both private and government) has been done by multiplying the percentage of various hospitals in the different ranges of bed strength.

The bed strength for the Sub-centre/PHC/CHC has been taken as per the fixed government norms of number of beds/ four to six beds and 30 beds respectively. Thus in the case of Sub-centres, the breakage is per centre rather than per bed.

Further Hg release was calculated by multiplying the content of Hg released from unit breakage of thermometers (0.001 kg) and loss in handling etc and (0.02 kg) for sphygmomanometers (Agrawal *et al.*, 2004).

2.3.4 Calculation of per capita mercury usage and released

Calculation of per capita Hg usage and released was calculated by dividing the estimated Hg usage and released by the population of India (1.14 billion) in year 2008 (Census, Government of India).

2.3.5 Policy impact analysis

The Government of Delhi's order for the phase out in year 2007 has definitely led to an increase in the market for alternative products, but the National guidelines issued by the DGHS of India, 2010 would have a much larger impact. The guidelines have been circulated to all the ministries under the Government of India that run health establishments including the Ministry of Health, Ministry of Defence, Ministry of Home Affairs, Ministry of Labour, Ministry of Railways, Ministry of Women & Child Development and Ministry of Panchayati Raj. The guidelines, apply to roughly 1,669 hospitals and 1,74,000 primary clinics and health centres (estimated numbers under the ministries mentioned above). Impact of these guidelines has been calculated assuming the best-case adoption scenario. These guidelines have the potential to evolve into a broader national policy on Hg in healthcare.

3. Results

3.1 Estimated annual mercury usage

The estimated annual Hg usage in thermometers and sphygmomanometers in the State of Maharashtra is the most (4.5 tons) followed by Gujarat (2.2 tons) and Uttar Pradesh (2 tons) (Table 4). In India, the total Hg usage in these instruments was 26 tons in the year 2008.

Details about hospital numbers, estimated number of thermometers and sphygmomanometers under rural and urban hospitals are given in Annexure 4.

Table 4: Mercury usage (kg) in healthcare instruments as per the state in India in the year 2008

States	Hg in Thermometer (Kg)	Hg in Sphygmomanometer (Kg)	Total Hg (Kg)	Share of respective states (%)
Andhra Pradesh	49	1705	1754	6.7
Arunachal Pradesh	2	72	75	0.3
Assam	15	453	468	1.8
Bihar	30	878	908	3.5
Chhattisgarh	17	545	562	2.2
Goa	1	62	64	0.2
Gujarat	53	2156	2209	8.5
Haryana	18	733	751	2.9
Himachal Pradesh	8	246	254	1.0
Jammu & Kashmir	7	209	216	0.8
Jharkhand	11	289	299	1.1
Karnataka	50	1797	1847	7.1
Kerala	25	917	943	3.6
Madhya Pradesh	34	1125	1158	4.4
Maharashtra	105	4480	4584	17.6

Contd...

Table 4: Mercury usage (kg) in healthcare instruments as per the state in India in the year 2008 (Contd.)				
States	Hg in Thermometer (Kg)	Hg in Sphygmomanometer (Kg)	Total Hg (Kg)	Share of respective states (%)
Manipur	1	41	43	0.2
Meghalaya	2	55	57	0.2
Mizoram	1	48	49	0.2
Nagaland	2	79	81	0.3
Orissa	24	690	713	2.7
Punjab	17	644	661	2.5
Rajasthan	39	1233	1271	4.9
Sikkim	0	12	13	0.0
Tamil Nadu	37	1306	1343	5.1
Tripura	2	71	73	0.3
Uttarakhand	25	1123	1147	4.4
Uttar Pradesh	68	1977	2045	7.8
West Bengal	45	1616	1660	6.4
A&N Islands	0	10	10	0.0
Chandigarh	1	73	74	0.3
D&N Haveli	0	5	5	0.0
Daman & Diu	0	16	16	0.1
Delhi	14	687	701	2.7
Lakshadweep	0	1	1	0.0
Puducherry	1	45	46	0.2

Table 5: Estimated amount of mercury in various types of healthcare settings in India				
Hospital types		Hg in Thermometers (Kg)	Hg in Sphygmomanometers (Kg)	Hg Kg
1. Rural-Government	1,a. Sub centre	292	8762	9054
	1,b. PHC	94	1407	1501
	1,c. CHC	21	257	278
2. Urban	2,a. Government	116	5828	5828
	2,b. Private	183	9147.2	16553

In the rural-government healthcare setting the Hg captured is 407 kilograms whereas urban hospitals have about half that amount.

From Fig. 1 it is clear that the Hg captured in the sphygmomanometer is significantly higher (25 tons) than that in a thermometer (0.7 tons), as there is 60 times the Hg content in the former. The Hg captured in the sphygmomanometers is around 36 times that of thermometers, though the Hg content in it is 60 times. This difference is due to the higher per hospital usage of thermometers than sphygmomanometers, which is around 1.7 times.

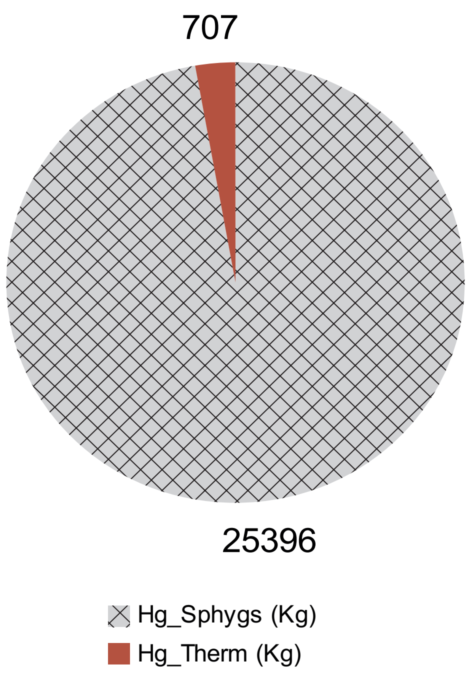

Fig. 1: Estimated amount of mercury in various types of healthcare settings in India

3.2 Expected addition in rural- government healthcare

According to the National Health Profile, 2009, the health services especially in rural India are in deficit and there is an immediate need to increase their numbers. The expected increase as per the requirement is given in Table 6.

Table 6 shows an urgent need for a policy, because, India is on the verge of adding more healthcare facilities both in the government and private sector (as mentioned above). Thus before huge investments are made in these hospitals the government should act proactively before any legally binding treaty limiting Hg use comes into force.

Table 6: Increase in mercury in the government's rural set-ups with proposed additions

Rural health care Hospitals (#)		Hg in Thermometers (Kg)	Hg in Sphygmomanometers (Kg)	Hg Kg
Sub centre	20855	42	1251	1293
PHC	4883	19	293	312
CHC	2525	13	151	164
Total (Rural)	28263	74	1696	1769

3.3 Estimated annual mercury release

Urban government hospitals and super speciality centres are major contributors to spillage due to their enormous sizes.

The private sector secures the second position. This sector, contributes a significant amount as compared to the rural health sector. The advantage with the private sector is that the beds are concentrated in a relatively fewer number of hospitals and they generally have good management systems in place. Due to increased competition in the healthcare services and big chains coming up as enterprises, there is a race to woo consumers and hospitals are looking for more accreditations. Thus, voluntary improvement will be quite evident in this sector. With more and more people going in for NABH (National Accreditation Board for Hospitals), ISO (International Standards Organisation), and OSHA (Occupational Safety and Health Administration) the possibility of a voluntary switch over to Hg alternates is a big possibility in this sector. Moreover, public awareness on Hg would also be a trigger for them to change over completely.

The rural healthcare sector has a wide outreach, but due to its small size, its stake in Hg emissions is quite low. Still the usage data shows that equipment turnover is almost 100 percent. Thus, a phased Hg replacement would not put any storage/ collection burden on these small facilities.

The government is surely the biggest player in healthcare delivery. The role of the private sector cannot be negated and this sector is emerging very strongly not just in the metropolises, but also in the so-called small towns of India. Thus, a national policy is needed to bring about a uniform change in the country. DGHS guidelines and voluntary phase out initiatives are big interim tools till that happens.

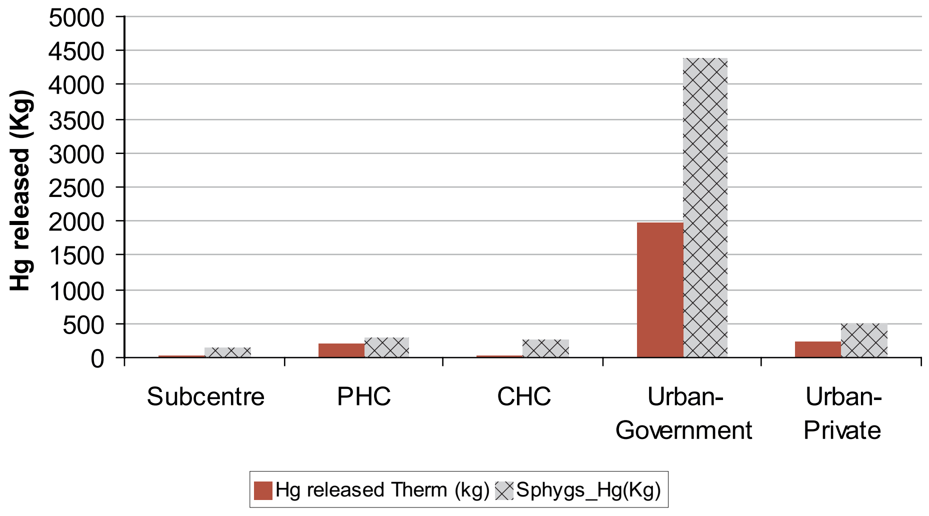

Fig 2: Estimated annual mercury release (kg) as a result of spills from thermometers and sphygmomanometers from healthcare settings in India

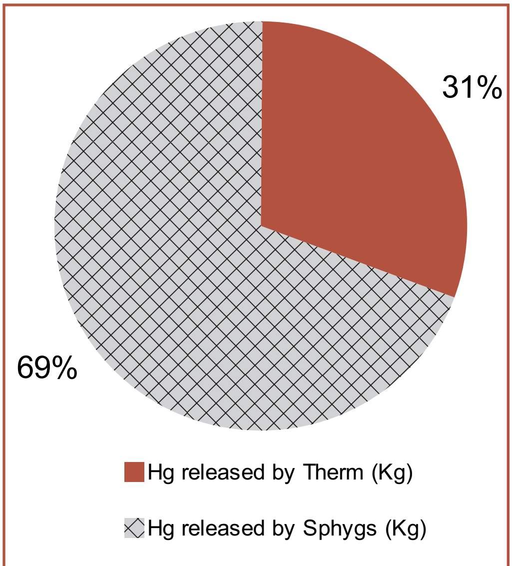

Fig 3: Estimated share (%) of annual mercury release as a result of spills from thermometers and sphygmomanometers from healthcare settings in India

The breakage rate of thermometers is much higher than that of sphygmomanometers, but due to the huge difference in the content of Hg in these, the Hg release is more significant in the case of sphygmomanometers. Most of the hospitals in the present study do not have in-house calibration units; they usually outsource the equipment for calibration or return it to the manufacturer. 69 percent of the Hg released from hospital equipment comes from sphygmomanometers, thus when hospitals change over to digital thermometers alone and think that they have done their bit, they should remember that the major hazard is still sitting with them. The government seriously needs to take up the accuracy and standardisation debate of sphygmomanometers to a positive conclusion. Each thermometer has Hg spillage content of around 1/20th of sphygmomanometers and the number of thermometers broken annually contributes to its spillage share by about 31 percent. This is due to a very high chance of breakage of this equipment, which is almost nine times that of sphygmomanometers (Table 3). The breakage is higher in bigger set ups with good occupancy and higher work pressures.

3.4. Per capita mercury stored and released by healthcare instruments

Considering the estimated annual Hg released by healthcare instruments to be eight tons, the per capita release comes to 7µg. These figures have been calculated for the year 2008, for the calculations, the Indian population for the same year has been considered as 1.14 billion (Government of India, Census). The Hg used in healthcare instruments was around 26 tons in the year 2008, thus the per capita Hg used in instruments is 22 mg.

3.5 Expected outcome from implemented policies

An almost 50 percent reduction (from 26 tons to 12 tons) in the demand for Hg equipment is expected as fallout of the DGHS guidelines. The Indian market players should promptly respond to this shift to be able to cater to this new market. There should be a mechanism for a government dialogue for the smooth transition of these production patterns. The government could also look into organising exchange programmes by acting as an interface between the hospitals and manufacturers. The government can also work out a mechanism to help cover the one time transition cost in the hospitals looking for that support.

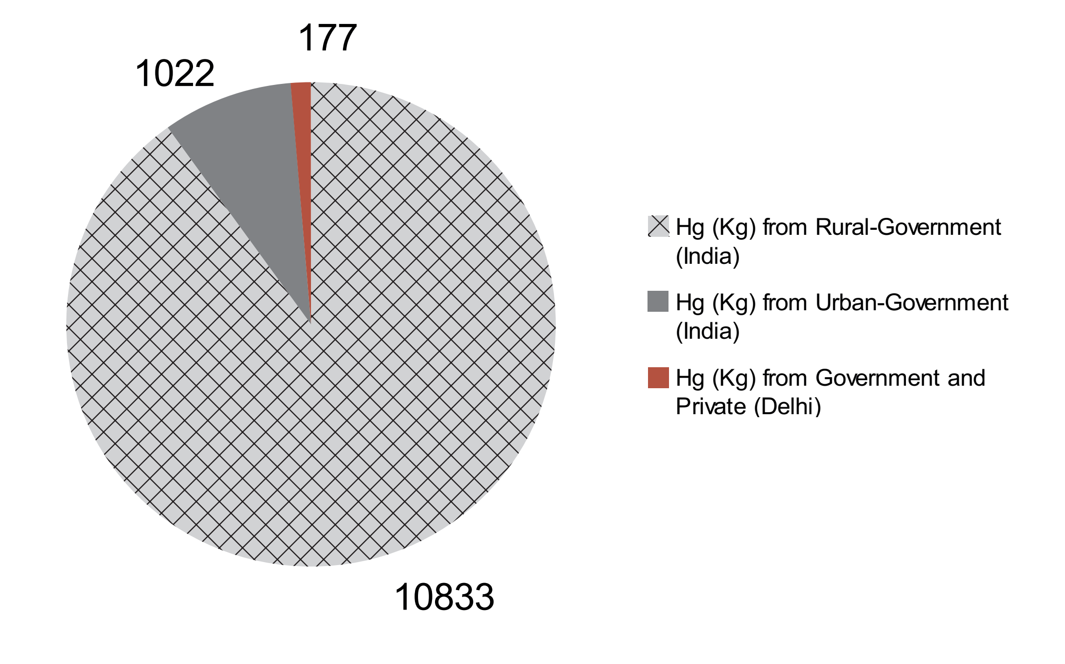

Fig. 4: Estimated decrease in usage of mercury containing equipment as a response to National guidelines and Delhi office order

4. Mercury storage in healthcare settings in Delhi

Delhi first picked up the Hg issue in 2004 and finally passed an office order mandating that healthcare establishments phase out the use of equipment containing Hg in 2007. Since then hospitals have been grappling with various issues like – storage of the abandoned equipment containing Hg and doctors' concerns about the accuracy of digital and aneroid sphygmomanometers.

Delhi has been included in the study to assess the Hg trapped in Delhi hospitals and to analyse the storage issues and problems and the ways and means that the hospitals have worked out to deal with the situation.

4.1 Mercury waste in healthcare settings in Delhi

The usage has been worked out according to the IPHS guidelines for different healthcare settings. The list of hospitals (both private and government) in different categories has been given in Annexure 3.

Most of the hospitals in Delhi have phased out equipment containing mercury. Fig. 5 highlights the problems of storing mercury in the city's

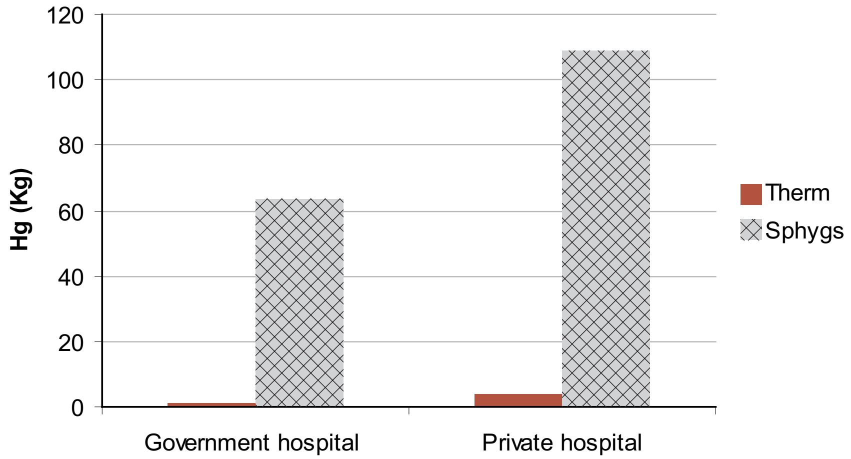

Fig. 5: Estimated Hg stored (kg) in healthcare settings in Delhi

hospitals. The total number of thermometers discarded from smaller private hospitals is much higher than that in bigger hospitals whereas it is vice-versa for the hospitals in the government sector. The collection of discarded instruments containing Hg from government hospitals will be much easier, as the maximum number (share) is with the larger hospitals. Evidently, there is an urgent need to address the storage issue at the policy level, as this may be a big bottleneck in the transition to Hg free alternates. Quantitatively this translates to around 177 kilograms of stored Hg in equipment alone.

4.2 Problems associated with the storage of phased out mercury devices

- **Current practices**

  Hg equipment is stored in simple cartons/ plastic boxes. Collected elemental Hg is stored in small plastic bottles with some water. In some hospitals, glass bottles are also used for bulk Hg, which seems very risky. Most of the hospitals stored Hg under water, but complained of the water evaporating over long periods of storage despite proper sealing of bottles. Fig. 6 shows the problems in the storage of discarded instruments and Hg waste collected in some Delhi hospitals.

- The storage sites are in the relatively hotter and less ventilated areas of the hospital (e.g. basement/ stores).

- Staffs' handling the Hg legacy is the least aware of its toxicity.

Currently there are no national or international policies/ guidelines on the storage of Hg. UNEP and GEF are both working on a document on this issue. Even the Central Pollution Control Board of India has started working on a draft guideline on Hg storage.

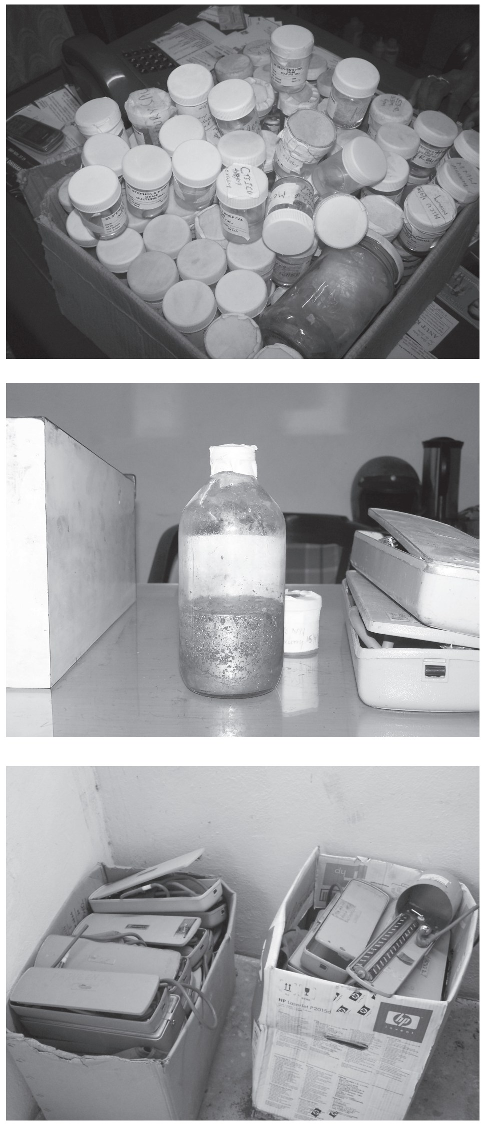

Fig. 6: Pictures showing the existing problems in final disposal of mercury-containing equipment

5. Limitations and further scope of the study

- Apart from the fever thermometer used in wards, they can also be found in the blood banks, incubators, water baths, and laboratories and these were not included in the present study. Even the dental amalgams were not touched. The study focussed on fever thermometers and sphygmomanometers only.
- The sample size is not very large; in future, a more comprehensive study can be done involving different states.
- In many states, records of the purchase/ breakage were not maintained. In some cases bulk purchases were made by central authorities for three to four years thus an annual figure was difficult to judge. Replenishment by the staff responsible for breaking the equipment has also led to an unclear picture (especially in the case of thermometers).
- Calibrations of sphygmomanometer were not done in-house in most of the cases so the situations under which the process happened could not be recorded.

Toxics Link's resources on mercury:

Reports/Films

- Fishing Toxics Mercury Contamination of Fish in West Bengal, 2010.
- Moving Towards Mercury- Free Health Care: Substituting Mercury-Based Medical Devices in India, 2009.
- Mercury in Hospital Indoor Air: Staff and Patients at Risk, 2007.
- Lurking Menace -Mercury in the healthcare sector, 2004.
- Mercury in India: Toxic Pathways, 2003.
- Mercury Trade (1.3 min), 2010.
- Mercury free hospital India (9 min), 2010.
- Mercury-No Silver Lining (15.5 min), 2007.
- Mercury spill Management (2 min), 2007.

References

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United Nations Environmental Programme (UNEP), 2002. http://www.unep.org/hazardoussubstances/Mercury/MercuryPublications/ReportsPublications

WHO, 2005, Mercury in Health Care, Policy paper, World Health Organisation, 2005. WHO/SDE/WSH/05.08. URL: (http://www.who.int/water_sanitation_health/medicalwaste/mercurypolpap230506.pdf)

http://www.noharm.org/global/issues/toxins/mercury/policies.php

http://statehealthsocietybihar.org/healthinfra.htm

http://www.delhi.gov.in/wps/wcm/connect/doit_health/Health/Home/DHS/Biomedical+Waste+Mgmt.

Annexure

Annexure 1: Number of health centres with respect to population in rural India		
Centre	Population Norms	
	Plain Area	Hilly/Tribal/Difficult Area
Sub-Centre	5000	3000
Primary Health Centre (PHC)	30,000	20,000
Community Health Centre (CHC)	1,20,000	80,000

Source: DGHS, 2007 (http://www.mohfw.nic.in)

Annexure 2: Number of hospitals under each type of healthcare settings from respective states in India

States UT	Sub Centres	PHCs	CHCs	Government	Private[a]
Andhra Pradesh	12522	1570	167	192	280
Arunachal Pradesh	592	116	44	15	0
Assam	4592	844	103	45	22
Bihar	8858	1641	70	123[b]	13
Chhattisgarh	4741	721	136	99	17
Goa	172	19	5	11	17
Gujarat	7174	1073	273	91	823
Haryana	2433	420	86	93	216
Himachal Pradesh	2071	449	73	47	3
Jammu & Kashmir	1907	375	85	31	6
Jharkhand	3958	330	194	0	11
Karnataka	8143	2195	323	451	192
Kerala	5094	909	107	105	201
Madhya Pradesh	8834	1149	270	102	181
Maharashtra	10579	1816	407	389	1673
Manipur	420	72	16	4	2

Contd...

Annexure 2: Contd.					
States UT	Sub Centres	PHCs	CHCs	Government	Private[a]
Meghalaya	401	103	26	10	3
Mizoram	366	57	9	10	2
Nagaland	397	86	21	25	2
Orissa	6688	1279	231	80	30
Punjab	2858	484	126	159	83
Rajasthan	10742	1503	349	128	137
Sikkim	147	24	4	1	0
Tamil Nadu	8706	1215	206	48	340
Tripura	579	76	11	15	2
Uttarakhand	1765	239	55	528	27
Uttar Pradesh	20521	3690	515	29	245
West Bengal	10356	924	349	280	230
A&N Islands	114	19	4	1	0
Chandigarh	14	0	2	5	35
D&N Haveli	38	6	1	1	0
Daman & Diu	22	3	1	3	5
Delhi	41	8	0	109	271
Lakshadweep	14	4	3	0	0
Puducherry	77	39	4	8	13

Source: Doctors Online (www.hindustanlinks.com, accessed on 21st June 2009, cross referred in Bureau of Energy Efficiency, 2009. Energy Efficiency in Hospitals, Best Practice Guide);

a: Extrapolated value for year 2008;

b: http://statehealthsocietybihar.org/healthinfra.htm

Annexure 3: Details about extrapolated number of hospitals under respective bed-strength window in India

Bed strength	<10	10-24	25-49	50-99	100-199	200-499	> 500
Urban-Private (no.)	2244	2004	499	139	102	65	28
Bed strength used (urban-private)	5	17	38	75	150	350	500
Bed strength	30	30-40	50-100	100-200	200-300	300-500	>500
Urban-Government (no.)	566	283	661	472	94	189	850
Bed strength used (urban-government)	30	35	75	150	250	400	1000

Source: Extrapolated from http://www.delhi.gov.in/wps/wcm/connect/doit_health/Health/Home/DHS/Biomedical+Waste+Mgmt.

Annexure 4: Estimated number of thermometers and sphygmomanometers used in the healthcare sector in India in the year 2008

Hospital types		Thermometers (#)	Sphygmomanometers(#)
1. Rural-Government	1,a. Sub centre	292072	146036
	1,b. PHC	93832	23458
	1,c. CHC	21380	4276
2. Urban	2,a. Government	116568	97140
	2,b. Private	182941	152451

Annexure 5: Number of hospitals in Delhi as per their bed strength

a. Private hospitals as per the bed strength in Delhi in the year 2004

Bed strength	< 10	10-24	25-49	50-99	100-199	200-499	> 500
Hospital no	243	217	54	15	11	7	3

b. Government hospitals as per the bed strength in Delhi in the year 2004

Bed strength	30	30-40	50-100	100-200	200-300	300-500	> 500
Hospital no	6	3	7	5	1	2	9

(Source: http://www.delhi.gov.in/wps/wcm/connect/doit_health/Health/Home/DHS/Biomedical+Waste+Mgmt)

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