Toxics Link
for a toxics-free world

# Mercury in Our Mouth

## An estimation of mercury usage and release from the Dental Sector in India

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Study by:
Toxics Link, New Delhi

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mercury working group

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## TOXICS LINK

Toxics Link is an environmental organisation, engaged in disseminating information and help strengthening campaigns against toxic pollution, providing cleaner alternatives and bringing 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."

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## 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. The 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.

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***Toxics Link***

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# Executive Summary

The healthcare sector is a key source of mercury's global demand and emissions and the Dental sector alone accounts for very high usage. The burden of dental caries is high among adults in most high-income countries. According to the WHO Global Oral Health Data Bank, the global dental caries index among children aged 12 years is 1.6 teeth on an average; however, there are marked differences in the severity of the disease amongst regions.

Despite the high levels of treatment needs, 90% of caries remains untreated. The types of restorative materials used in dental schools vary between countries, as do costs of materials. According to a survey 70% of the Indian population has caries and about 58% of that population visits a dentist. The principal material types for direct restoration are: dental amalgam (silver-tin-copper amalgams containing mercury); resin-based composite materials (RBC); modifications of RBCs (poly-acid modified composites); compomers and giomers (glass filler modified composites) and glass-ionomer cements or water-based cements.

Dental amalgam contains about 50% mercury, as well as other toxic metals such as tin, copper, nickel, palladium, etc. With every filling around 15-50% residual non-contact amalgam gets thrown into the bins or goes to the sewer after the procedure of dental restoration. Moreover, there is a study that points out that 70% of the new fillings are replacement of the old fillings, thus each year these removed fillings either go down the drain or get thrown in the bins. Cremation and burial are also important sources of mercury emissions into the environment. Dental fillings are supposed to be one of the important sources of exposure of elemental ($Hg^0$) in people having amalgam fillings. Chewing as well as hot food can trigger release of mercury vapour from dental fillings.

The use of dental amalgam is declining in general, and the declining trend could be attributed to the improved dental health of people and the increased availability of other aesthetic restorative materials.

Major findings of the report are:

1. **Mercury use by the Dental Sector**
   - In recent years composites have largely replaced mercury fillings, the estimated annual use of mercury in this sector stands around 65 tons, where 49 tons gets into cavities and 16.2 tons is mostly thrown into the environment as non-contact amalgam.

The National Rural Health Mission is working to strengthen the medical infrastructure at the levels of Community Health Centres. This would lead to an expected addition of 6500 dentists providing improved dental services to the rural population leading to increased mercury consumption by approximately ~ 11.2 ton annually

A major shift has been seen in the metropolitan and other cities in India, where the use of amalgam fillings has largely been replaced by alternatives. The scenario in the rural sector however was quite different as per the survey. This is the place where a government intervention is required to sustain the efforts of the private sector in removing mercury from the dental sector in India. If there is no policy intervention from the government the use of mercury in the Indian Dental sector is bound to increase by ~16% / year and the mercury in the Indian population is set to rise by 2.8 times in the coming years.

## 2. Estimated Mercury captured in dental fillings in the Indian population

In the present scenario where only 26% fillings are done using mercury, about 206 tons of mercury exists in the standing Indian population.
Taking into account the mercury fillings done in the past and the fact that the average life of these fillings is around 8-10 years, mercury in the population can be approximated to 396 tons, though this figure would be based largely on assumptions as discussed later.

Considering that by 2012 there would be one dentist per CHC, 42% population with caries which didn't have an easy access to medical care would now have an accessible medical facility. This would increase the estimated mercury captured in the Indian population by 574t. This would amount to a 2.8 times increase.

## 3. Annual release of mercury

The average mercury release due to non-contact amalgam generated per year in the country is estimated to be around 16 tons and this amount would largely end up in water bodies of the country, where it would be transformed readily into methyl mercury and enter the food chain through water animals.

The estimated annual mercury release due to removal or replacement of old fillings (contact amalgam) is 66 ton. This amount would mostly end up in municipal bins and thus soil and groundwater. These two mediums are also rich in micro-organisms responsible for methylation of mercury

It is estimated that India would release around 1.4 tons of mercury from mercury fillings during cremations.

The total mercury air emissions from contact amalgam, non-contact amalgam and cremations comes to around 14 tons.

1ton of mercury would be released into the waste waters due to the leaching of mercury from the amalgam fillings of the Indian population annually.

## 4. Comparative analysis of choice of dental restorative material in sampled Indian cities and the country-side

A comparative analysis shows an increased inclination towards non-amalgam dental fillings though the trend decreases from urban to rural areas. On an average, the estimated ratio of mercury filling to alternate filling in India stands at 1.75:4.9.

## 5. Reasons for the shift towards alternate restorative materials

The reason for this shift to mercury alternates as reported by the doctors was patient satisfaction due to its aesthetic value. An awareness about mercury toxicity in metros was also noticed in a few patients. This trend fades away in smaller towns and cost of the filling becomes a priority (the cost which largely ignores the hidden cost of using mercury).

# 1. Introduction

## 1.1 Background

The heavy metal mercury (Hg), is a persistent pollutant of global concern because of it's physico- chemical properties and toxicity. It can cross the boundaries of the nation of its origin, can contaminate soil and water mainly through wet deposition and cause a threat to humans and the wildlife. It can be transformed from its elemental ( $Hg^0$) to organic form (methyl-mercury) in the environment when it comes in contact with anaerobic microbes. Hg- is one of the ten chemicals causing a major public health concern that WHO prioritizes.

The healthcare sector is a key source of mercury's global demand and emissions. The main consumers of Hg in the health care sector are health care instruments and dental restorations.

Dental amalgam contains about 50 % mercury, as well as other toxic metals such as tin, copper, nickel, palladium, etc. The contact amalgam (generated due to removal of old fillings and due to polishing of the new ones) and the residual non-contact amalgam (the amalgam which has been prepared but never gets filled) gets thrown into the bins or goes to the sewer or emitted into the air during the procedure of dental restoration. Cremation is also an important source of mercury emissions into the air. Worldwide, dental mercury has been recognised as an important source of mercury release into the environment[1].

According to UNEP, a total of 260 to 340 tons of Hg- is annually released into the environment from the use of dental amalgam globally **(Annexure 1)**.

The amount of mercury released into the environment from over 800,000 dental offices is estimated between 0.04 and 0.2% of total worldwide environmental Hg- pollution from all sources[2]. The annual cost to the dental industry of reducing one ton of potentially bio available Hg- is about US 273 million $ to 1.2 billion $.

Dental fillings are supposed to be one of the important sources of exposure to $Hg^0$ in people who have got amalgam filling[3]. There is evidence that chewing as well as eating hot food can trigger the release of mercury vapor from dental fillings[4]. Very small amounts are slowly released from the surface of the filling due to corrosion or chewing or grinding motions. Part of the mercury on the surface of the filling may enter the air as mercury vapor or be dissolved in the saliva. The total amount of mercury released from dental amalgam depends on the total number of fillings and the surface of each filling.

The Precautionary Principle is perhaps best enunciated within the Wingspread consensus statement[5], as follows:

**"Where an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."**

## 1.2 The situation of dental caries and restorative materials

The burden of dental caries is high among adults in most high-income countries. At present, the disease level is lower in the low income countries of Africa and Asia, meanwhile, reports are now available on a growing burden of dental caries among adults living in middle income countries. Globally, dental caries affects 60-90% of school-aged children[6]. According to the WHO Global Oral Health Data Bank, the global dental caries index among children aged 12 years is 1.6 teeth on an average; however, there are marked differences in the severity of the disease amongst various regions. Despite the high levels of treatment needs, 90% of caries remains untreated. The types of restorative materials used in dental schools vary between countries, as do costs of the materials.

**The Indian Scenario**

According to a survey 70% of the Indian population has caries and about 58% of that population visits a dentist[7].

Prevalence of dental caries is high & provision for restorative treatment is inadequate in most parts of the country. DCI's National survey has been conducted to determine the prevalence of dental diseases in different states of India. Prevalence of dental caries is 40%-80% (Very high in Northern states 85%-90%), periodontal conditions usually increase with age and are found more in rural areas. Oral cancer and precancerous conditions are 3%-10% (the highest being in Orissa 7% (world's highest)[8].

## 1.3 Exposure to Mercury

Mercury exists in various forms, and people are exposed to each of them in different ways. The most common ways people are exposed to mercury is by eating fish containing methyl mercury, from using or breaking products containing mercury. Mercury is emitted into the air by human activities, such as manufacturing processes or burning coal using mercury, as fuel, and naturally by sources like volcanoes.[9]

Exposure to $Hg^0$ is predominantly via the lung, with reported absorption ranging from 61 to 86% of the vapor inhaled[10]. The primary organ of deposition is the kidney, with lesser amounts in the liver, the central nervous system and other tissues[11].

$Hg^0$ crosses the blood-brain barrier[12] and once in the brain, it is oxidized to $Hg^{2+}$, which binds it to sulphydryl groups of proteins. $Hg^{2+}$ cannot readily cross the blood-brain barrier and is thereby 'trapped' in the brain or central nervous system[13]. Whereas the whole-body half-life of $Hg^0$ is approximately 60 days[14], the half-life of Hg in the brain extends for decades[15].

At present, more than six agencies have prescribed reference exposure levels (REL) for $Hg^0$, for risk assessment of general (non-occupational) population exposures:

- California Environmental Protection Agency in 2008: 0.03 µg/m3;
- Canadian Federal Department of Health (Health Canada) in 2008: 0.06 µg/m3;
- Lettmeier et al. (2010): 0.07 µg/m3;
- US Agency for Toxic Substances and Disease Registry (USATSDR) in 1999: 0.2 µg/m3;
- US Environmental Protection Agency in 1995: 0.3 µg/m3; and
- European office of the World Health Organization in 2000: 1 µg Hg0/m3[16]

The mercury body burden of dental personnel is normally higher than in the general population. The mean urine mercury levels in dental personnel have been reported to range from 3 µg/l to 22 µg/l, compared to 1-5 µg/l as the normal range for non-occupational groups[17]. This increased body burden is attributed to the practices that the dental personnel are involved in, like mixing and applying dental amalgam and removing amalgam restorations;[18] showed that on an average, urinary mercury levels in dentists is about 4 times that of control subjects.

## 1.4 Types of dental restorative materials

The principal material types for direct restoration are:

- Dental amalgam (silver-tin-copper amalgams containing mercury).
- Resin-based composite materials (RBC).
- Modifications of RBCs (poly-acid modified composites); compomers and
- Giomers (glass filler modified composites).
- Glass-ionomer cements/water-based cements: Self-setting ("pure" glass-ionomers) or, more usually, light cured (resin modified glass-ionomers).

The indications for use of restorative materials span from small cavities to extensive loss of tooth substance. Research into a material that is based on the technology of glass ionomers, low shrinking resins and high strength filters with simple handling and acceptable longevity is in progress[19].

While some countries (e.g. Indonesia) use more composites and glass ionomers, dental amalgam is still most frequent in other countries. Patients' preference and demand, site of lesions, type of dentition, cost, cost-effectiveness, training and treatment philosophy are some of the influencing factors. While dental amalgam restorations are still taught in the dental curriculum, much emphasis is placed on tooth-coloured restorative materials, leading to an increasing trend in using more composite resins and glass ionomer than amalgam. Manufacturers also have an important part to play in ensuring that the materials are readily accessible, easy to use and cost-effective.

## 1.5 Initiatives in phasing out amalgam from dental sector

Under the auspices of the United Nations Environment Programme (UNEP), discussions on the reduction of mercury use are also taking place internationally. Negotiations began in 2010 and shall be completed by 2013. Dental amalgam is amongst the products currently discussed as potential candidates for being regulated.

UNEP, together with WHO, launched a guidance document entitled "Identifying

Populations at Risk from Mercury Exposure"[20]. This document is intended to assist countries concerned about the potential national impacts of Hg- pollution to identify specific populations or subpopulations that may be at risk.

WHO is committed to work with the health sector and national, regional and global health partners so as to:

- Reduce mercury exposure;
- Eliminate the use of mercury wherever possible;
- Promote the development of alternatives to the use of mercury.
- Lead the profession in the negotiations of the development of a legally binding instrument on mercury.

In 1994, Sweden announced the phase-out of dental amalgam and has completely banned it now. Norway started its phase-out programme from July 2003 and is completely amalgam free now. Denmark banned dental amalgam with an exception of its use in molar teeth restoration. Dental amalgam is used in less than 3% of new fillings in Japan.

## 1.6 Mercury released from Crematoria

Mercury is another environmental pollutant usually emitted during incineration[21]. In crematories, mercury enters the process because it is present in the body being cremated. Mercury will leak from the fillings in the deceased's body because of mercury's low vapor pressure and add to the mercury levels already present in the body. Studies have found as much as 200 µg/m3 of mercury during the cremation process of a body with dental amalgam fillings[22].

## 1.7 Contact and Non-contact amalgam

Mercury for dental use can be obtained in two ways. The first, and the most widely used way in India is, to buy silver alloy and mercury separately and mix them. The second way is to buy capsules containing pre-measured amounts of mercury, silver, zinc and other alloys. The capsules are available in three sizes: single (400 mg of material), double (600 mg), or triple (800 mg). A membrane present inside the capsule keeps the mercury separated from the silver, zinc, and other alloys. Once the mercury is in contact with the other materials, it bonds to them rapidly and the mixture begins to harden quickly.

As much as up to 15-50% of the amalgam may remain unused after the use. The disposal of amalgam depends on how it was used. The excess amalgam that is unused after a tooth is filled is called 'non-contact' amalgam: it was never placed into a tooth and was never in contact with any human tissue. Contact amalgam is amalgam that has been in contact with human teeth or tissue. Processes like replacing amalgam fillings, polishing a fresh amalgam filling to remove the excess amalgam can generate contact amalgam.

## 1.8 Mercury release due to leaching of amalgam fillings

The only stable form of mercury at room temperature is as a gas, and since amalgam is a mixed metal it is subject to galvanic (battery effect)/Electromagnetic Fields (EMF) induced electrical currents that pump the metals into the oral cavity. Mercury begins vaporizing at 10 degrees Fahrenheit and the vapor pressure doubles for each additional 10 degrees centigrade. Thus a person with amalgams gets a high level of mercury vapor exposure through oral air and extremely high levels of deposited metals including mercury in the oral cavity, from which mercury is transported to all other major organs. Those with several amalgam fillings have mercury excretion levels 10 times the average of those without amalgam, and after amalgam replacement most have reductions of 90% in mercury level in saliva and excretion. Daily exposure to mercury in these people exceeds Government Health Guidelines for Mercury Exposure.

Dental amalgam is the largest source of mercury in sewers and sewer sludge. Municipal sewer agencies and EPA have found the average person with several fillings excretes approximately 30 micrograms of mercury into the sewers, and dental offices also have large amounts of mercury going into sewers[23].

The mercury release estimates from amalgam in the mouth of inhabitants in Sweden were based on excretion rates of 60 µg/ (day*person) with faeces and urine (citing and did not include contributions from food intake These results should be seen in the context that other mercury input sources to waste water are likely to be minimal in Sweden compared to many other places in the world (Sweden is perhaps one of the countries where mercury has been regulated most strictly for several decades).[24]

Every mercury amalgam filling releases to the order of 10 micrograms of mercury daily into the body.

## 1.9 Environmental costs associated with mercury pollution prevention

While most dentists using mercury amalgams typically charge somewhat less for amalgams than for the alternatives, the full costs borne by the rest of society are much higher after taking into account the overall environmental health ramifications. Once dental mercury has been used, there are a number of "end-of-pipe" techniques to keep it from entering the environment, but each of these techniques comes at a (sometimes very high) cost, and may not be as effective as hoped for. Since it is internationally agreed that the global pool of mercury circulating in the biosphere needs to be greatly reduced, society's choice is straightforward – either we are obliged to pay such costs to ensure that mercury does not eventually enter the environment, alternatively stop using mercury fillings[25]. A study which tried to calculate the

remediation costs of contaminated sites in Sweden and Japan revealed point pollution sources globally and their remediation costs ranged between 2500 and 1.1 million US$ kg–.11Hg isolated from the biosphere. Therefore, regulations discontinuing mercury uses combined with extensive flue gas cleaning for all power plants and waste incinerators are cost effective[26].

## 1.10 Dental Sector and National Rural Health Mission

Only 15 – 20% of people in India are able to get dental services through national schemes. The annual per capita public health expenditure in India is no more than Rs.200.8 Thus, reach and quality of public health services have been below desirable standards. 80-85% of people are spending money from their own pocket. It may be due to this fact; seeking - oral health care has a low priority in India, people rarely visit the dentist and that too only in the event of pain. Although huge unmet treatment needs exists; striking inequality in the delivery system and the absence of an adequate community-oriented prevention system is further aggravating the lack of the reach of dental facilities in parts of rural India.)

Oral & Dental Health Service delivery had been confined to the district hospital, only with basic curative facility till late. With the advent of NRHM it is envisioned to place Dental surgeons in all CHCs. According to a NRHM document, 6500 CHCs have been strengthened/ established with 7 specialists and 9staff nurses to provide service guarantees as per IPHS-30% by 2007, 50% by 2009 and 100% by 2012[27]

According to a planning Commission document, at the CHC level, Rajasthan leads with 2.3 specialists on an average, followed by 1.8 for Uttar Pradesh, all employed on a regular basis. Next on the list is Andhra Pradesh, with 1.3 specialists employed on an average, fifty percent of whom are employed on a contractual basis. Finally, Bihar, employing 0.8 specialists per CHC on average, with all hired on a PPP revenue-generation model basis (i.e. the CHC sublets space to private practitioners, such as dentists, who bring their own equipment and who charge the patient a user fee at rates subscribed by the state health society, sometimes sharing a certain proportion of the fee with the CHC).[28]

Thus it is obvious that with deadlines approaching and a very effective NRHM in place, India is heading towards good medical care at the rural level, which has been ignored till late.

Extrapolating the addition of 1 dental surgeon at each CHC all over the country and taking into account the data from the rural sector in India it can be assumed that about 100% fillings in this sector would be done using amalgam.

About 42% of India's population with caries that did not have an easy access to a dentist would now have it at the CHC level.

## 1.11 Dentists, Dental institutions and Dental practitioners in India

There is a staggering number of 289 dental schools in India producing more than 30,000 graduates every year. [Dental Council of India's) figures. - 30,570 / Year] More than 2800 postgraduate students are enrolled every year in various specialties of dentistry. (Dental Council of India's) figures. - 2,881 / Year).29

WHO recommends, a dentist to population ratio of 1:7500. Dentists-to-population ratio of India, which was 1:300,000 in the 1960's, stands at 1:10,000 today. However, the number of dentists' in the Indian Army is far higher at 1: 5,000; due to the fact that it is mandatory for each person to have at least one dental examination in a year in the Army[29].

India is not short of dentists, but the problem lies at the level of distribution of dental surgeons. About 80% of dentists work in major cities in India; though more than 70% of Indians reside in the rural areas. Very few oral health care services are provided in the rural areas, and seekers of oral healthcare among the rural population are very few in number. A mismatch exists between oral health professionals & the population they serve.

At present, in rural India one dentist is serving 2.5 lakh people whereas; the overall ratio of dentists to population in India is 1: 10,000. Reports suggest that there are about more than one million unqualified dental health-care providers, or 'quacks', in India.

## 1.12 Dental Insurance in India

There aren't any dental insurance plans currently available in India on a stand-alone basis. Insurance companies provide dental care benefits in case hospitalisation is required, for example, or in the case of an accident, requiring dental surgery. Apart from that, products, which are common in the west, that provide dental benefits are not available currently in India[30].

Recently ICICI Lombard has launched the `Health Advantage Plus Health Insurance Policy' which covers unexpected medical emergencies like hospitalisation costs as well as Outpatient Treatment Expenses (OPD) in the form of reimbursement of cost of medicines, drugs, ambulance charges and dental expenses.

Reimbursement of OPD expenses up to Rs. 10,000/-, includes diagnostics tests, dental treatment, etc.

## 1.13 Dental Mercury and Intergovernmental Negotiating Committee

The United States government announced that it supports a "phase down, with the goal of eventual phase out by all parties, of mercury amalgam." This statement, a radical reversal of its former position, was part of the U.S. government's submission for the third round of negotiations for the world mercury treaty.

**This new U.S. position made three significant breakthroughs for the mercury-free dentistry movement:**

1. The U.S. called for the phase-out of amalgam ultimately and recommended actions to "phase down" its use immediately.
2. The U.S. spoke up for protecting children and fetuses from amalgam, recommending that the nations "educate patients and parents in order to protect children and fetuses."
3. The U.S. stood up for the human right of every patient and parent to make educated decisions about amalgam[31].

Similarly when the World Health Organization released its 2009 meeting report on the "Future Use of Materials for Dental Restorations" in preparation for the third of five Inter- governmental Committee deliberations, it was hailed by consumer groups as a "breakthrough,". The report suggests, over time, the global "phase down" of amalgam[32].

## 1.14 Objectives of the study

There is a complete lack of understanding on the extent of Hg-used and released from dentistry in India. Though the study published by Toxics Link, 2004[33] estimated that about 51 kgs of Hg-are annually thrown into the general bins or drained into sewers by the Delhi's dental sector.

The focus of the present study is on the quantification of Hg-usage and release in the environment due to the dental sector in India.

Objectives and scope of the report:

a. To make a detailed inventory of Hg usage in the dental sector.
b. To estimate the mercury present in the Indian Population due to dental fillings.
c. To make a detailed inventory of Hg release in the environment through non-contact amalgam, dental refilling or replacement with alternates, cremation, leaching
d. To analyse the cost difference paid by patients for dental restoration with amalgam and alternates\.
e. To study the relative share of mercury and alternate restorative materials used.
f. To analyse some practice issues in Indian dentistry, like ventilation, use of protective gears, use of amalgamators etc.

# 2. Sampling

Questionnaire based approach (Annexure 2) was adopted for the sampling of mercury use and waste management practices by registered dentists in 10-states of India (Himachal Pradesh, Haryana, Delhi, Uttar Pradesh, Bihar, Jharkhand, Odisha, Goa, Tamil Nadu, Maharashtra). The main components of the questionnaire were information on average dental fillings done per dentist/day, annual purchase of mercury, average amount of amalgam used per filling, to understand the process of amalgam preparation i.e., whether amalgamator is used and capsules used or amalgam is made manually with loose mercury. Further, questions were also framed with regard to the age of patients seen, number of fillings/patient, restoration material used, the cost difference in amalgam and alternate dental filling (Rs.) and waste management practices for the mercury containing waste.

**Table 1: Detail of sample size of dental hospital and clinics from 10-states of India**

| State | Number of Clinics | No of Hospitals | Total |
|---|---|---|---|
| Bihar | 1 | 3 | 4 |
| Haryana | 3 | 0 | 3 |
| Goa | 25 | 5 | 30 |
| Himachal Pradesh | 16 | 8 | 24 |
| Jharkhand | 16 | 1 | 17 |
| Orissa | 27 | 3 | 30 |
| Tamil Nadu | 11 | 1 | 12 |
| Uttar Pradesh | 28 | 3 | 31 |
| Delhi | 5 | 13 | 18 |
| Pune | 52 | 5 | 57 |
| Overall | 184 | 42 | 226 |

# 3. Methodology

Number of dental surgeons in India for the year 2011 was 1.21 lakhs, calculated on the basis of the ratio of dentists: population ratio of 1:10,000.(Ahuja, Parmar IJD) The average amount of mercury used in each filling taken under this study was 0.75 gm per filling (this includes the amount of mercury which goes into the tooth and the amount of contact mercury that is released during polishing).

**Table 2: Review of amount of mercury used per restoration per teeth**

| References | Mercury/filling (g) |
|---|---|
| Yoshida and Kishimoto, 1994[34] | 0.6 |
| USFDA[35] | 1 |
| Dutch Anti-Amalgam Foundation, Netherlands[36] | 1 |
| Average used under this study | 0.75 |

## 3.1 Estimation of mercury use in dental sector

Based on survey results from 10-states, the average number of patients treated (restorations and others) per day by each dentist was found to be 11, whereas the number of teeth restored by a dentist per day was 6.65. An estimation of the total amount of mercury used in dental fillings for the year 2011 was done taking into account the actual proportion (1.75 out of 6.6 fillings are done using mercury) from the findings of our survey. The average working days for a dentist have been assumed to be 313 days in a year (There are around 1.2 lakh dentists in India and only around 5500 are in the government sector. According to the survey most of the private practitioners have 6 working days.). The amount of non-contact amalgam generated in each dental restoration can be (on an average) 32.5% of the actual amount of mercury filled in each restoration. To estimate total mercury used in the dental sector, the amount of mercury put into each filling and amount of non-contact amalgam were taken into account.

Eqn. 1-3 was used to estimate the amount of mercury used in the dental sector in the year 2011 in India.

$$T_{AC} = (NA_{DF} \times N_D \times N_i \times C_{Hg}) \quad 1)$$

$$T_{ANC} = T_{AC} \times .325 \quad 2)$$

$$CA_{Hg} = T_{AC} + T_{ANC} \quad 4)$$

Where,

$T_{AC}$ = Amount of mercury used in dental restoration per year;

$NA_{DF}$ = Number of patients treated with amalgam (1.75 per day/dentist, survey findings);

$N_D$ = Number of Dentists (1.21 lakh);

$N_i$ = No of days in a year (313 days);

$C_{Hg}$ = Average amount of Hg used in each filling (T) (0.75 g *10-6Hg in each filling);

$T_{ANC}$ = Average amount of mercury generated by non-contact amalgam (T)(32.5% of $T_{AC}$);

$CA_{Hg}$ = amount of mercury used in the dental sector in India

$T_{AC} = (NA_{DF} \times N_D \times N_i \times C_{Hg})$
$= (1.75*121000*313*0.75\ g\ *10\text{-}6)$
$= 49.6T$

$T_{ANC}$ = TAC x .325 = 49T*.325 = 16T

### 3.1.1 Amount of Mercury Used and NRHM

The number of working days for the doctors in the government sector has been taken as 267).

$T_{hg\text{-}CHC} = (N_{F/CHC/Yr}*0.75*10^{-6}) + (N_{F/CHC/Yr}*0.75*10^{-6})$ .325

Where

$N_{F/D/Yr}$ = No. of fillings/dentist/year= 6.6 (fillings/day)*267 (No. of working Days) = 1775.55

$N_{F/CHC/Yr}$ = Total no. of fillings in CHCs/year
$= N_{F/D/Yr}*6500$ (Total No. of CHCs)
= 11541075

$T_{hg\text{-}CHC}$ = Total amount of mercury used in CHCs/year = $(N_{F/CHC/Yr}*0.75*10^{-6}) + (N_{F/CHC/Yr}*0.75*10^{-6}).325$ = Total mercury in filling + non-contact amalgam generated/filling

$T_{hg\text{-}CHC} = (N_{F/CHC/Yr}*0.75*10^{-6}) + (N_{F/CHC/Yr}*0.75*10^{-6}).325 = (11541075*.75*10^{-6}) + (8.7).325$

= 8.7+2.8=11.5T

### 3.1.2 Comparison of estimated Hg use in dentistry in India with mercury procurement by dentists

The total mercury purchased by the dental sector was calculated by multiplying the total number of dentists with the average amount of mercury purchased by the dentists / year (as per the survey result)

$T_{hgpr/year} = T_{hgpr/D}*N_D$

*Where*

$T_{hgpr/year}$ = Mercury procured by dentists per year (T)

$T_{hgpr/D}$ = Total mercury procured by a dentist per year (T) $(595gm*10^{-6})$

$N_D$ = Number of Dentists in India (1.2 lakhs)

$T_{hgpr/year} = T_{hgpr/D}*N_D = 595gm*10\text{-}6*121000 = 72T$

## 3.2 Estimation of mercury trapped in the oral cavities of the Indian population

The total population of India as per census of the year 2011 was 1.21 billion.[37]

About 70% of the Indian population has caries and about 58% of that population visits a dentist[38].

Furthermore, assuming that the average Indian population has 2.15 numbers of fillings (from our survey) the total number of fillings in the standing population of India was calculated as:

$P_F = (T_I \times IPc) \times PV_D$ 4)
$= (1210000000*\ 0.7)*0.58 = 491260000$

Where,

$P_F$ = Population of India with fillings;

$T_I$ = Total Indian population;

IPc = 0.7= 70% of the Indian population has caries:

$PV_D$ = 0.58= 58% of that population visits a dentist;

$T_F = P_F \times NF_P$ 5)
$T_F = P_F \times NF_P = 491260000*2.15 = 1056209000$

Where,

$T_F$ = Total number of fillings in the population;

$NF_p$ = Number of dental fillings per person in average Indian (2.15 teeth);

$P_I$, as given in Eqn. 4.

$$T_{Hgf} = T_F \times 0.26 \quad 6)$$

$$T_{Hgf} = T_F \times 0.26 = 1056209000*0.26 = 274614340$$

$$T_{hg} = (T_{HgF} \times 0.75) \times 10^{-6} \quad 7)$$

$$T_{hg} = (T_{HgF} \times 0.75) \times 10^{-6} = (274614340 \times 0.75) \times 10^{-6} = 206T$$

Where,

$T_{Hgf}$ = Total number of mercury fillings in the Population (only 26% of fillings being mercury-amalgam);

$T_{hg} \sim T_{Hg26\%}$ = Total Mercury in the Population due to dental amalgam (Ton)

Mercury used/filling (T) = (0.75gm) x $10^{-6}$

# 3.3 Estimation of mercury release in waste stream

The total amount of mercury release from the dental sector was estimated taking into account a quantum of non-contact amalgam generated during a new filling, and mercury release due to contact amalgam generated due to removal of old fillings.

## 3.3.1 Annual generation of non- contact amalgam

Assuming that 15-50% of the amalgam made during the process of filling remains unused, the amount of amalgam waste generated per year has been calculated as in Eqn. 1-3

## 3.3.2 Mercury released per year due to contact amalgam (due to removal) (ton)

According to some studies about 70% of the dental fillings are replacements of the old fillings. Thus the replacement factor was taken to estimate a total no of fillings removed in the year 2011 (**Eqn. 9**). Furthermore, the total mercury released per year due to contact amalgam (due to removal) (ton) was estimated using **Eqn. 10**.

$$T_{FR} = (NA_{DF} \times N_D \times N_i)0.7 \quad 9)$$

$$ToHg/yr = T_{FR} \times T_{MR/f} \quad 10)$$

$$T_{FR} = (NA_{DF} \times N_D \times N_i)0.7 = (6.6*121000*313)0.7 = 176217157$$

$$ToHg/yr = T_{FR} \times T_{MR/f} = 176217157*(0.375*10^{-6}) = 66T$$

Where,

$NA_{DF}$ = 6.6 = Number of fillings done/dentist/day (assuming that the fillings removed had been done in 2000 and all were Hg fillings)

$T_{FR}$ = Fillings removed (70% of the new fillings);

$N_D$ and Ni as in Eqn 1

$T_{MR/f}$ = Mercury released/filling (0.75*10-6)/2 (assuming 50% loss due to various reasons as cited)

ToHg/yr = Total mercury released/yr due to contact amalgam (Ton)

## 3.3.3 Estimation of mercury release through the crematoria

Around 83% of the total Indian population is cremated (2001 Census) thus it would be a significant source of mercury air emissions. http://www.indiaonlinepages.com/population/religious-population-in-india.html

Generally, in children a mercury free miracle mix is used and by the age of 65, people start losing their filled tooth. Thus the population range of ages 15 to 65 was studied. Also, the death rate amongst this population was noted to calculate the emissions from cremations. This population range has been taken to prevent any overestimation. It is assumed that 50% of the total mercury is lost during the life of the amalgam and thus just 50% is emitted during cremations.

The release of mercury through crematoria was estimated, taking into account factors like the total Indian population in the year 2011; the percentage of the population using the custom of cremation, and death rate in the age bracket (15-65).

$Tc = T_p \times Tc\%$ 11)

$T_{PC15\text{-}65} = Tc \times T_{p15\text{-}65}$ 12)

Where,

$T_p$ = Total population of India (2011) 1.2 billion;

Tc% = Percentage of population with custom of cremation (83.5);

Tc = Total population with custom of cremation (1.01 Billion);

$T_{p15\text{-}65\%}$ = Percentage of population in the age bracket between 15 to 65 years (64.3%);

$T_{PC15\text{-}65}$ = Population in age bracket 15-65 (650 Million)

Further, total deaths and cremation in the year was estimated taking the average death rate (6.4 deaths per 1000 population). http://www.who.int/whosis/indicators/compendium/2008/1mst/en/index.html

$Tc = T_p \times Tc\%$ =121000000*83.5= 1010350000

$T_{PC15\text{-}65} = Tc \times T_{p15\text{-}6}$ = 1010350000*.643 = 649655050

$T_{DC/\,yr15\text{-}65} = (T_{PC15\text{-}65} \times 6.4)/1000$ = (649655050*6.4)/1000 = 4157792.32

$T_{DC/\,yr15\text{-}65} = (T_{PC15\text{-}65} \times 6.4)/1000$ 13)

Where,

$T_{DC/\,yr15\text{-}65}$ = Total deaths and cremations/year assuming death rate of 6.4 (= 4.1 million);

Further, cremated population having caries (TCC) was calculated as, 1.6 million assuming 70% had caries and of this 58% had dental restoration done (Eqn. 14).

$T_{CC} = (T_{DC/\,yr15\text{-}65} \times 0.7) \times 0.58$ 14)

$T_{FCP} = T_{CC} \times T_{FP}$ 15)

$T_{Hgc}$ (T) $= T_{FCP} \times (0.75 \times 10^{-6})/2$ 16)

Where,

$T_{FP}$ = No. of fillings / patient (2.15);

$T_{FCP}$ = Total fillings in cremated population/ year (3.6 million);

$T_{Hgc}$ (T) = Total mercury released per year through cremations (ton) (assumes 50% mercury loss during use, though this factor would be an underestimation of mercury released.

$T_{CC}$ = (4157792.32x 0.7) x 0.58 = 1688063.68

$T_{FCP}$ = TCC x TFP =1688063.68*2.15=3629336.92

$T_{Hgc}$ (T) = 3629336.92 x $(0.75 \times 10^{-6})/2$= 1.36

## 3.3.4 Estimation of mercury release due to leaching of fillings

$T_{hgl} = T_{Hgf} * Tl/d*365$

Where

$T_{hgl}$ = Total mercury released in the water system by the population with mercury fillings/year due to leaching of mercury from the fillings

$T_{Hgf}$ as in Equation 6

$T_{l/d}$ = $10*10^{-12}$ T (release of 10microgram/filling/day)365 = No. of days in a year

$T_{hgl} = T_{Hgf} * T_{l/d} *365=274614340*10*10^{-12}$ T*365 = 1T

## 3.3.5 Estimation of mercury release in various ecosystems

Assuming (as per the survey findings) that most of the contact amalgam (due to removal of old fillings) is discharged into the municipal waste water system, the disposal matrix can be used to estimate the mercury in various media[1]. Similarly the disposal matrix for non-contact amalgam can be worked out by assuming that most of this waste ends up in the municipal bins. The contact amalgam generated due to polishing of the fillings would mostly be airborne

**Table 3: Disposal matrix used to estimate mercury in various ecosystems**

| | Municipal solid waste system (%) | Municipal wastewater system (%) |
|---|---|---|
| Atmosphere | 30 | 10 |
| Surface water | 10 | 40 |
| Groundwater | 10 | 20 |
| Soil | 50 | 30 |

*Reference: (Maxson, 2007)[1]*

# 4. Results and discussion

## 4.1 Estimated mercury used by the dental sector in year 2011 taking dentists as its base

The mercury used in the dental sector in year 2011 was calculated taking into account the number of dentists and number of fillings done/dentist/year. The estimated total number of dental fillings done in year 2011, in India was 251 $x10^6$.

Under the present scenario where composites (74%) have largely replaced mercury-amalgam fillings (26%) the estimated amount of mercury used by this sector was 65 ton (49 ton in the dental filling +16.2 tons in the form of non-contact amalgam respectively) in year 2011.

### 4.1.1 Estimated amount of mercury used by the dental sector under NRHM in year 2009 taking dentists as a base

Assuming the addition of 6500 dentists in the CHCs by 2012 as speculated by the Government, the additional increase in mercury demand would be around 11.2 tons. This is around 16% increased usage /year.

### 4.1.2 Comparison of estimated Hg use in dentistry in India with mercury procurement by dentists

According to the results of our survey the average amount of mercury used per dentist per year is about 595g. Considering that the number of dentists in India is 121000, the estimated total Hg use in dentistry in India per year is 72 Tons.

An estimate of mercury usage in dentistry, based on an average amount of mercury fillings done by the doctors in a year comes to 65 tons. The mercury estimated to be procured by the dentists/year is much more than its expected use. This difference can be due to several reasons- like, 1) the average amount of mercury used varies from 0.4g to 1.0g whereas we have considered a figure of 0.75g under the current study, 2) the wastage could be higher than speculated 3) doctors could have given very rough approximates of their usage

## 4.2 Estimated mercury captured in Indian population in dental fillings in year 2009

According to the survey, the average dental fillings per person were 2.15 and out of these fillings around 26% are mercury and rest are alternates. Taking the survey figures of 26% mercury fillings we estimate a figure of 206 tons of captured mercury in the Indian population due to the dental fillings. This figure would be an underestimation because the average life of dental fillings is about 8-10 years. Assuming an average of 50% mercury fillings in the population (considering that amalgam fillings were 100% in 2000 and through these ten years have seen a gradual decline to 26%), the mercury in the mouth of the Indian population can be around 396T.

Considering that by 2012 there would be one dentist per CHC, 42% population with caries which didn't have easy access to medical care, would now have an easily accessible medical facility. This would increase the estimated mercury captured in the Indian population by 574 T. It would lead to a 2.8 times increase in mercury in the Indian population.

## 4.3 Release of mercury from the dental sector

The dental sector releases mercury in the form of non-contact amalgam, contact amalgam (during polishing of the new filling and due to removal of old amalgam fillings) and via cremation.

### 4.3.1 Non-contact amalgam generated/year in India

The average non-contact amalgam generated/year in India is about 16tons. Most of this amount lands up in municipal bins, thus ending up either in the soil or in groundwater. Some of the dentists say that they did not have any problems in collecting this waste, but there are hardly any mechanisms to collect and dispose off this hazardous waste scientifically. Moreover, because of the lack of any laws and disposal fees on generating this waste there is no incentive to reduce its generation.

### 4.3.2 Mercury release due to removal of old fillings

The estimated number of dental restorations performed in India/year is about 251 million. According to research around 70% of these fillings are due to removal of old fillings. Thus every year 176 million old mercury fillings are removed either by choice (for example for aesthetic reasons with alternate) or necessity (loss in functionality of old fillings). Assuming, 50% of mercury in the old fillings is lost during use (0.375 g gets lost due to leaching while in use), 66 Ton of mercury waste can be generated as a result of removal of -filling alone in India/ year. We have assumed here that all the fillings removed were mercury fillings, because the average life of a mercury filling is around 8-10 years and around year 2000, most of the fillings were done using mercury. But, according to some dentists in Delhi, they had started using alternatives in 2000, though they had not completely changed over to it. If we assume that 75% of the removed fillings were mercury fillings the release comes to around 49.5 T.

Even while removal of these fillings no extra precaution is taken to avoid exposure to mercury to the patient or the healthcare staff.

### 4.3.3 Estimation of mercury release through the crematoria

India would emit around 1.4 Ton of mercury from dental amalgam fillings during cremations annually. Just to prevent any overestimation it has been assumed here that all the fillings have only around 50% of the mercury present in the original fillings. Even burial of the bodies would lead to emission of mercury into the environment, but that has not been calculated.

## 4.3.4 Estimation of mercury release due to leaching of fillings

1Ton of mercury would be released in the waste waters due to the leaching of mercury from the amalgam fillings in the Indian Population annually. An additional 2.8Tons could be added to the annual release of mercury to the water bodies, when NRHM is able to achieve its targets by 2012 (and the 42% untreated caries is attended to).

## 4.3.5 Release of mercury in various media

**Table 4: Media matrix for estimated mercury release generated in year 2009**

| | Hg (ton)-(contact amalgam Removal of amalgam filling | Hg (ton) -Non contact amalgam | Hg (on)-cremation |
|---|---|---|---|
| Atmosphere | 6.6 | 4.8 | 1.4 |
| Surface water | 26.4 | 1.6 | NA |
| Groundwater | 13.2 | 1.6 | NA |
| Soil | 19.8 | 8.1 | NA |

Thus the total release of mercury from the dental restoration sector could be about 83.4 tons whereas emission into the air would be ~12.8tons; from contact amalgam, non-contact amalgam and cremations respectively (6.6 Tons, 4.8tons and 1.4 tons respectively).

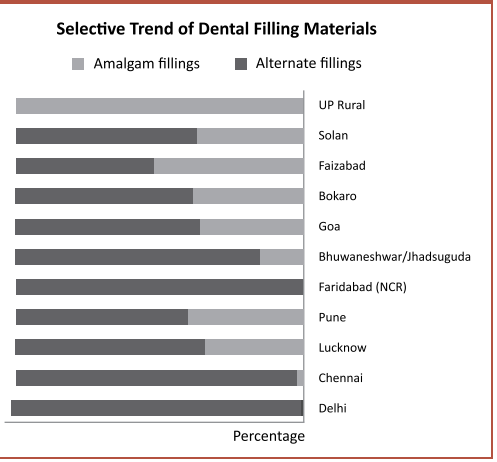
# 5. Other key findings from the study

## 5.1 Comparative analysis of choice of dental restorative material in sampled Indian cities and the country-side

**Table 5: Comparative table of choice of dental restorative material in sampled places**

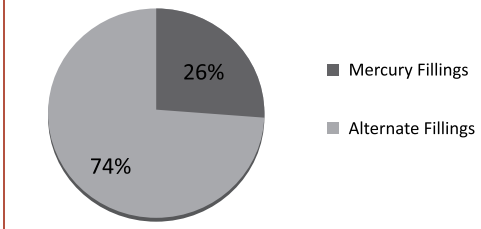
| City | Amalgam fillings (%) | Alternate fillings (%) |
|---|---|---|
| Delhi | 0 | 100 |
| Chennai | 3 | 97 |
| Lucknow | 34 | 66 |
| Pune | 40 | 60 |
| Faridabad (NCR) | 0 | 100 |
| Bhuwaneshwar/ Jhadsuguda | 15 | 85 |
| Goa | 36 | 64 |
| Bokaro | 38 | 62 |
| Faizabad | 52 | 48 |
| Solan | 37 | 63 |
| UP Rural | 100 | 0 |

**Fig. 1: Comparative analysis of choice of dental restorative material in sampled Indian cities and the country-side**




An increased inclination towards amalgam dental filling could be seen as we moved from urban to rural areas. While in Delhi and NCR nearly all the fillings were now being done with alternate materials, in rural places the figure is just the opposite, with all of them still using mercury as a preferred filling material. The estimated ratio of mercury filling to alternate filling in India stands at 1.75:4.9

**Fig. 2: Number of Patients/Day**

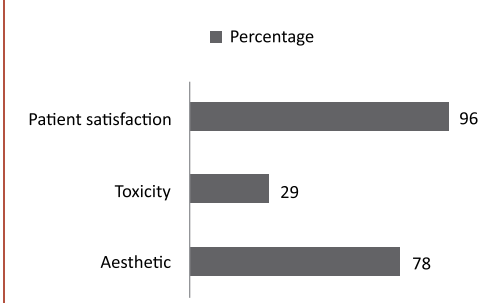



Therefore the percentage of mercury fillings is 26.32%

## 5.2 Reasons for the shift towards alternate restorative materials

The reasons for this shift as reported by the doctors were found to be patient satisfaction as a major factor as well as being aesthetically pleasing. The awareness about the toxicity of mercury is not the main cause for this shift, but some people were aware of it. Most of the doctors state that the major reason for the shift is aesthetics. Even people from lower economic groups are aware of tooth coloured fillings and the younger generation does not mind the relatively higher cost and are willing to shell out the extra bit.

**Fig. 3: Reasons of Shift**



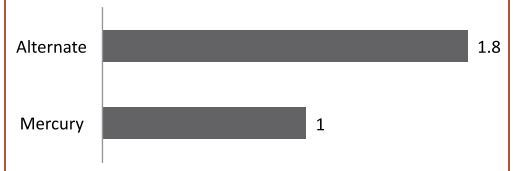

Few patients in metros were also aware of the toxicity caused by mercury and according to some doctors patients were coming in for replacement of mercury filling by composites, due to this reason.

Thus, overall patient satisfaction appears to be the major driving force behind the shift in the dental sector.

## 5.3 Cost comparison of amalgam and alternate filling

Based upon the survey, the cost of alternate based dental filling was found to be just double of the one with mercury based (amalgam).

**Fig. 4: Cost of Amalgam Vs Alternative (ratio)**




In most of the cases the cost of mercury fillings was nearly half that of the composites. The reason for the cost difference is the difference in the cost of the materials and the time the doctor's invested.

The bonding agent used in the composites is an additional requirement. A 2ml bottle of this agent costs Rs. 3500 and approximately 2 drops costing about Rs. 140 of this agent is used per filling. The composite fillings require isolation and a complete dry field and thus relatively twice the amount of time is required to do composites as compared to mercury fillings. In the government sector this price difference has been reduced. Increased usage might further bring down the cost of these fillings.

Taking into consideration the cost of installation of equipment to prevent mercury from reaching the environment, the mercury fillings turn out much more expensive. In the sampled clinics even basic equipment like amalgamators (to prevent exposure to the staff) were not being used. Only teaching institutes were found to have these machines. Amalgam separators to collect mercury waste were available only in a premier dental college. Here also, the separators were not used

appropriately and the waste was not discarded in the proper manner. If the dentists were supposed to install equipment to prevent mercury entering the environment the added cost would dissuade the doctors from using mercury and also the patients would not be interested in paying the higher environmental bills of using mercury.

## 5.4 Comparing the average life of amalgam and alternate filling

Based upon our primary survey, we can state that the average life of mercury fillings was found to be longer than the alternate fillings, being 8 and 6 respectively.

According to the respondents the probability of mercury filling staying in place for more than 10 years is much higher than alternates. This data is based on the perception of doctors' and has no scientific co-relation.

**Fig. 5: Average life of fillings (years)**


**Table 6: Average life of fillings**

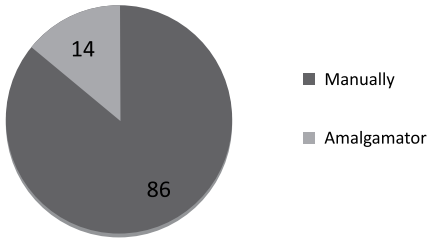
| | Amalgam (%) | Alternate (%) |
|---|---|---|
| upto 5 | 23 | 48 |
| 5 to 10 | 45 | 45 |
| above 10 | 31 | 7 |

## 5.5 Mode of amalgam preparation

Only 14% of the dentists were found to be preparing amalgam using an amalgamator and a substantial percentage, 86% were doing it manually.

Amalgam preparation is mostly done manually and without any protective gear. In most of the clinics dental assistants do this work. An amalgamator is usually used in bigger set ups and hospitals, clinics manned by one doctor mostly have manual mixing. According to the doctors, amalgamator uses capsules and leads to more wastage than manual mixing. Though the amalgamator avoids occupational exposure to mercury, it is avoided as its use has not been made mandatory.

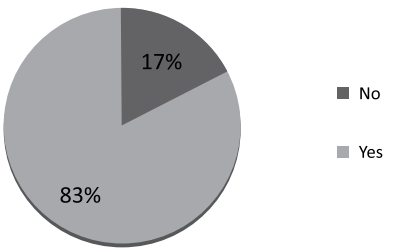
**Fig. 6: Mode of Amalgam Preparation**




## 5.6 Use of protective gears

While 83% of the dentists use protective gears while performing a dental filling, 17% of the dentists surveyed don't use any protective gears. The use of the protective gears mostly starts when the doctor is examining/ performing any procedures on the patient. It is generally never used during amalgam preparation.

**Fig. 7: Use of Protective Gears**



# 6. Conclusion

This study on estimation of mercury usage in dentistry has brought to fore some interesting details on mercury usage in dental health settings in India. The result indicates that dentistry perhaps is one of the largest consumers of mercury though data also suggests that there is a noticeable percentage of young dentists shifting to alternates of mercury amalgams. There is a growing awareness among the dentists on environmental and health impacts of mercury and various triggers for shift from mercury to alternates. The aesthetic value with the alternative filling material seems to be a major driving force for an increase in the number of these restorations. Increasing awareness about mercury toxicity in metro cities cannot be negated as the second contributor to the shift. Some dentists in metro cities have been seeing patients with intact mercury fillings coming for replacements only because of the threat of mercury toxicity.,

The shifts are largely confined to private dental clinics and private practioners whereas government clinics still prefer mercury for dental restorations and with significant increase of coverage in dental health delivered through the national health mission the consumption of mercury is expected to grow manifold and will require policy intervention to alter this growth.

The data as presented in this study is also an attempt to initiate a conversation on usage of mercury in dentistry as the estimates do suggest that the quantity used is significantly very large and this process requires to be checked and reversed. Need for policy directive and active engagement of stakeholders is critical to change the trend.

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# Annexure – I

| Global annual mercury releases from the use of dental amalgam | |
|---|---|
| **Main releases/pathways** | **Hg (MT/Year)** |
| Atmosphere | 50-70 |
| Surface water | 35-45 |
| Ground water | 20-25 |
| Soil | 75-100 |
| Recycling of dental amalgam | 40-50 |
| Sequestered, secure disposal | 40-50 |
| Total | 260-340 |

*Source: Future use of materials for dental restoration: report of the meeting convened at WHO HQ Geneva, Switzerland 16th to 17th November 2009/ prepared by Dr. Poul Erik Petersen. [et al]*

# Annexure – II

| Questionnaire used to survey usage of mercury and disposal practices of amalgam in India | |
|---|---|
| **1. Hospital** | **Your response** |
| 1. Hospital/clinic | 1) Government 2) Private |
| 2. No. of patients treated/day | 1) Cosmetic- 2) Restorative- |
| 3. Purchase of mercury-amalgam/ year | 2008- 2009- |
| 4. Are you using any Mercury traps or separators in your facility? | 75-100 |
| Recycling of dental amalgam | 40-50 |
| Sequestered, secure disposal | 40-50 |
| Total | 260-340 |

| **2. Dentist** | **Your response** |
|---|---|
| 1. Average dental fillings done per dentist/day | 1) With Amalgam- 2) Others- |
| 2. Average amount of amalgam used per filling | |
| 3. Number of persons (dentists and technicians) involved during the entire process i.e. from amalgam preparation to dental filling | |
| 4. Whether amalgamator is there/amalgam is made manually? | |
| 5. What kind of amalgam are you using? | 1) Pre encapsulated amalgam alloy 2) Manually mixed alloy |
| 6. Whether you are aware of mercury toxicity? | |
| 7. What is the Cost per dental filling (Rs.) | 1) Amalgam- 2) Alternate- |
| 8. Average life of a dental filling | 1) Amalgam- 2) Alternate- |
| 9. Your experience with alternate material | 2) Pros of alternates- 2) Cons of alternates 3) Patient Satisfaction |

| 3. Patient | |
|---|---|
| 1. Age of the patient (yrs) | 1) Below 10 -<br>2) 10-30 -<br>3) 31-65 - |
| 2. Existing no of teeth already filled with mercury amalgams | 1) 1<br>2) 2<br>3) 3<br>4) 4<br>5) Other |

| 4. Practices | |
|---|---|
| 1. Whether protective gears used during the whole process | |
| 2. Ventilation in the ward. | 1) Windows open-<br>2) Windows close- |
| 3. Anything else you would like to share | |

| 5. Waste management | |
|---|---|
| 2. How is amalgam waste collected and treated? | 1) Any chemical treated-<br>2) Disposal- |
| 4. Whether mercury-spill reported? | 1) Yes 2) No |
| 5. In case of spillage of mercury, what's done? | 1) Spill collection-with broom/ in dustbins/with cardboard<br>2) Unattended- |
| 5. Amount of mercury going into the waste after each filling | 1) Amalgam-<br>2) Mercury- |

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