

## MANAGEMENT OF MERCURY TOXICITY-A BRIEF REVIEW FROM AYURVEDIC CLASSICS

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### ABSTRACT

Mercury toxicity is major health concern globally. A detailed exploratory knowledge of Mercury toxicity and toxicity due to improperly prepared and administered mercurial formulations has been mentioned in ancient Ayurvedic classics and ancient classics of Rasashastra. Principles, guidelines of management and regime, formulations for management of mercurial toxicity are mentioned in several Ayurvedic classics but compilatory work is lacking hence an attempt has been made to compile it. Principles and guidelines and regimes or modules mentioned for management of mercury toxicity reveals that, the management has been mentioned under heading “*Rasajirna chikitsa*” and even separate chapter for management of its

toxicity has been mentioned in Bhaishajya Ratnavali; text of 16<sup>th</sup> century AD. Principles and modules like “*Dushi visha chikitsa*”, “*Bhakshana vidhana*” or “*Sevana samskara*” including (*Kshetrikarana, Kitapatana, Panchakarma, Rasayana*), *Pathya, Apathya, Anupana* during consumption of mercurial may be used for management of mercurial toxicity. Ayurveda has unique concepts of management of mercurial toxicity apart from contemporary principle of chelation and cleansing. These principles of management and protocols have potential to prevent different complications (manifestations) of mercurial toxicity. Principles used for its management and its classical method of administration, may open new arena of management of mercury toxicity in contemporary age.

**KEYWORDS:** Mercury toxicity, Chelation, Heavy metal, Rasaushadhi, Mercurial formulations.

## INTRODUCTION

Mercury toxicity is major health concern globally and it is still more in urban, industrialized areas and in developing countries. Mercury is till the date being used widely in many spheres of life and ultimately released in environment including public health (medicines, in dentistry, sphygmomanometers etc), household shores (LED lamps), mining (gold extraction), industry, electricity generation (thermal plants) etc. In spite of Minamata convention for complete global ban of Mercury by 2020,<sup>[1]</sup> its use and release in environment is still a major health concern. Chronic, mild mercurial toxicity may go unnoticed which may cause few irreversible complications like Neurotoxicity, nephrotoxicity and may hamper quality of life unnoticeably by mild deafness, vision impairment, memory loss, insomnia and digestive disturbances etc.<sup>[2,3,4]</sup> As Mercurials are extensively mentioned in Ayurvedic classics and widely used in Ayurvedic therapeutics, Ancient scholars of Ayurveda has kept in mind the possibility of exhibition of untoward and toxic effects during handling(manufacture, packaging, storage, dispensing, consumption) of Ayurvedic mercurial formulations (if either not prepared or used as per classical recommendations). A detailed exploratory knowledge of Mercury toxicity and toxicity due to improperly prepared and administered mercurial formulations has been mentioned in ancient Ayurvedic classics and ancient classics of Rasashastra.<sup>[5]</sup> Principles, guidelines of management and regime, formulations for management of mercurial toxicity are mentioned in several Ayurvedic classics. In present work, attempt has been made to compile information on Ayurvedic management of mercurial toxicity along with principles, modules, protocols and other possible principles and protocols, measures probably useful for its management along with suitable and possible justifications. The potential of this knowledge to explore new ways for management of Mercury toxicity in contemporary science has been discussed.

Chelation therapy used in heavy metal poisoning in contemporary medicine must be administered with care as it has a number of possible side effects including death.<sup>[6]</sup> Chelators bind to heavy metal forming soluble metal complexes (chelates), capable to get excreted and thus can also bind to important minerals in body, such as calcium and iron, which are essential trace elements for human body.

## MATERIAL AND METHODS

Ancient classical Ayurvedic books and ancient books on Rasashastra (total 20) written in and before 16<sup>th</sup> century AD were screened for principles and guidelines and regimes or modules

mentioned for management of mercury toxicity and possible therapeutic measures, procedures mentioned in Ayurveda or classics of Rasashastra which may be used for its management were screened and compiled.<sup>[7,8]</sup> Brief review of management of mercurial toxicity especially chronic oral mercurial toxicity was conducted from available textbooks of contemporary toxicology,<sup>[9]</sup> pharmacology, research journals<sup>[10]</sup> and authentic documents of government<sup>[11,12]</sup> and non governmental organizations for exploration of possible mechanism of action of Ayurvedic protocols or its similarity with contemporary principles and protocol for discussion purpose only. Justifications where possible for logical use of such principles or regime of management of Mercury toxicity are discussed.

### OBSERVATIONS

Review of Ancient classical Ayurvedic books and ancient books on Rasashastra written in and before 16<sup>th</sup> century AD for principles and guidelines and regimes or modules mentioned for management of mercury toxicity reveals that, the management has been mentioned under heading *Rasajirna*<sup>[13,14]</sup> *chikitsa*<sup>[15]</sup> and even separate chapter for management of its toxicity has been mentioned in text Bhaishajya Ratnavali. Screening for possible therapeutic measures, procedures mentioned in Ayurveda or classics of Rasashastra which may be used for management of mercurial toxicity shows that principles of management of *dushivisha chikitsa* (Avoiding of source of poisoning, *Panchakarma* and specific medicinal management like *dushivishari agada*),<sup>[16]</sup> *Dehavedha*<sup>[17,18]</sup> (safe use of mercurials to maintain, improve health, prevent and treat diseases, rejuvenate and provide longevity with quality health), *kshetrikarana* [*shodhana* by *panchakarma* (*Pachana, Snehana, Swedana, vamana, Virechana* in a sequence) at least *virechana*, followed by multiple modules like consumption of *Rasayana* (rejuvenating drugs), *Kitapatana* (measures for expulsion of worms)<sup>[19,20]</sup> and their therapeutic regimes as well as other therapeutic modules like measures mentioned for facilitation of *Kramana* of mercurial formulations in body, *Bhakshana vidhana*<sup>[21]</sup> or *sevana samskara*<sup>[22]</sup> (method or protocol for consumption of Mercurial formulations), *Pathya* (useful, recommended life style and oral indicated dietary ingredients or dietary recipes), *Anupana* recommended during consumption of mercurial formulations and *Anupana* etc. can be used for this. Avoidance of *Apathya* (Diet, dietary recipes and lifestyle mentioned to avoid) during consumption of mercurial formulation mentioned in classics can also be a part of management of mercurial toxicity. Therapeutic regime or module for management of Mercury toxicity as per Ayurvedic classics<sup>[23]</sup> has been presented in table number 1-5. Detailed description of possible therapeutic measures, procedures mentioned in Ayurveda or

classics of Rasashastra which may be used for management of mercurial toxicity is out of scope of present work hence avoided.

## TABLES

**Table no. 1: Therapeutic regime or module for management of Mercury toxicity (chronic oral) as per Bhaishajya Ratnavali.<sup>[24]</sup>**

Sr No	Therapeutic regime or module
1	<i>Shuddha Gandhaka</i> 500mg per day with honey.
2	Decoction ( <i>Kwatha</i> ) of <i>Triphala</i> , <i>Katuki</i> , <i>Shatavari</i> , <i>Patola</i> , <i>Guduchi</i> and <i>Parpataka</i> all equal in quantity boiled together and consumed in the dose of 50ml-100ml/day orally.
3	Decoction of <i>Katuki</i> , <i>Guduchi</i> , <i>Sariva</i> , <i>Gorakshamundi</i> , <i>Shatavari</i> , <i>Haritaki</i> , <i>Shyama</i> , <i>Bhringaraja</i> , <i>bruhati</i> , fruit pulp of <i>Bilva</i> (Bel) and <i>Amalaki</i> , all equal in quantity boiled together and consumed in the dose of 50ml-100ml /day orally.
4	<i>Sarivadyavaleha</i> , 12gms along with cow's milk, 2 times/day.
5	Coconut water for drinking.
6	For nausea, eructation –administer Curd with cooked fish along with cumin.
7	Massage with <i>Vatagnataila</i> (Medicated oils like <i>Narayanataila</i> )
8	For Uneasiness and anxiety, keep cloth soaked in cold water over head.
9	<i>Gugguladi Kwatha</i> mentioned in the chapter of <i>Vatarakta chikitsa</i> .
10	Medicines mentioned under the chapter of <i>Vata Rakta</i> , <i>Kushtha</i> (Skin diseases).
11	<i>Taila-Maharudra</i> , <i>Vranarakshasa</i> , <i>Kandarpasara taila</i> , <i>Bruhat marichadya</i>
12	<i>Anantadya Ghrita</i> mentioned in the chapter of <i>Upadamsha</i> treatment.
13	<i>Pathya</i> and <i>Apathya</i> mentioned under chapter of treatment of <i>Vatarakta</i> and <i>Kushtha</i> should be followed.

**Note-**Each regime is separate protocol.

**Table no. 2: Therapeutic regime or module for management of Mercury toxicity as per other Ayurvedic classics and classics on Rasashastra.**

Sr No	Therapeutic regime or module
1	If patient is on mercurial treatment, stop treatment with mercurial and treat with other medicines
2	Consumption of Cow's milk for 7 days.
3	Therapeutic Vomiting as <i>Panchakarma shodhana</i> procedure (bio- purification) should be done.
4	For purgesis ( <i>virechana</i> , Bio-purification) administer-Juice of Bitter melon (50ml) along with 12 gms of <i>Swarjikshara</i> (Sodium bicarbonatedecahydrate) twice a day. Or Cow's urine along with Rock salt twice a day.
5	Juice of <i>karkoti</i> and bitterguard added with equal quantity of rock salt and <i>Sauvarchala lavana</i> . (Black salt).
6	Combined decoction of <i>Sharapunkha</i> , <i>Devadali</i> , <i>Patola beeja</i> and <i>kakamachi</i> 100ml/day for 3 days.
7	<i>Kanji</i> (sour fermented gruel) along with <i>Sarjikakshara</i> , juice of bitter melon and cows urine along with rock salt.
8	Juice of <i>Rajakoshataki</i> (yellow bottle guard)
9	<i>Sauvarchala lavana</i> (Black salt) along with cow's urine

10	Juice of root of <i>karkoti</i> or it's decoction should be taken along with equal quantity of cow's urine and added with rock salt and <i>sauvarchala</i> for 3 days.
11	Juice of <i>Matulunga</i> ( <i>Citrus medica</i> , citrus fruit) or juice of it's root and ginger powder along with rock salt should be taken empty stomach in morning.
12	Decoction of any one among <i>Sharapunkha</i> , <i>Devadali</i> , <i>Patola</i> , <i>Bimbi</i> and <i>Kakamachi</i> .
13	<i>Kakarashataka-Kadali</i> , <i>kushmanda</i> , <i>Karkati</i> , <i>karavellaka</i> , <i>kakamachi</i> , <i>kalinga</i> , <i>kusumbha</i> , <i>karkotaka</i>
14	Total 50 gms of coarse powder of <i>Rajakoshataki</i> , <i>Garudi</i> , <i>Karavellika</i> , <i>karkotaki</i> , <i>kakamachi</i> , <i>Devadali</i> , <i>Aparajita</i> all together added with 200ml of cow's urine, boiled and reduced to 50 ml . This Decoction is added with 12 gms of Rock salt and consumed for 3 days.
15	<i>Shuddha gandhaka</i> 1.6gms-2gms per day alone or <i>Shuddha Gandhaka</i> ( <i>Sulphur</i> ) with <i>Nagvalli</i> ( <i>piper betel</i> ) <sup>[25]</sup>
16	Ghee along with powder of black pepper.
17	Coriander along with <i>haritaki</i> .
18	Decoction of excreta of buffalo.
19	800ml of Juice of Beetle leaves along with equal in quantity juice of <i>Bhringaraja</i> .
20	800ml of Juice of Indian holy basil leaves ( <i>Ocimum sanctum</i> , <i>Tulasi</i> ) along with equal in quantity Goat's milk.
21	Ginger powder and rock salt along with Lemon juice ( <i>Matulunga</i> ) for 3 days.
22	Juice of Drumstick or Decoction of <i>karkotaki</i> for 3 days.
23	<i>Agasti</i> , <i>Bhrungaraja</i> , <i>Romak lavana</i> levigated with Buttermilk for 4 days should be consumed with buttermilk.

**Table no. 3: Treatment of specific complications of Mercury toxicity.**

Sr No	Specific complication / condition of Mercury toxicity	Therapeutic regime or module
1	For treatment of toxicity of Mercury due to consumption of Mercurial adulterated with other unwanted, non processed potentially hazardous metals like Lead.	Juice of root of bitter melon or Juice of bitter melon root along with cow urine in equal quantity added with rock salt. Or ingestion of decoction of root of any one along with cow's urine - <i>Karkotaki</i> , clove or <i>patal garudi</i> .
	For treatment of toxicity of Mercury due to consumption of Mercurial adulterated with other unwanted, non processed potentially hazardous metals like Tin.	Decoction of <i>Sharpumkha</i> root.
2	Constipation	Powder of long pepper 1gm along with powder of <i>Haritaki</i> (3gms) at night
3	Dizziness, giddiness and drowsiness ( <i>Glani</i> , <i>Arati</i> )	Sprinkle cold water over head
4	Thirst	Coconut water, soup of green gram with sugar.
5	Nausea, eructation	Curd , black cumin along with rock salt

**Table No. 4: *Kramana yoga* for Mercury (Absorption, metabolism, distribution and excretion without any harm).**

Sr. No	Therapeutic regime or module
	Buttermilk prepared from cow's milk, sugar and honey should be consumed.
1	Beetle nut ( <i>Pugaphala</i> ) levigated with Ginger juice and butter should be consumed.
2	<i>Rasaka</i> or <i>Kharpara</i> (ore of zinc, Zinc carbonate) Roots of vegetables, roots of fruits yielding trees.
3	Administration of <i>Shuddha gandhaka</i> .

**Table no. 5: Other recommendations for management of mercurial toxicity.**

Sr. No	Therapeutic regime or module
1	In acute toxicity, avoid food for 3 days (Fasting).
2	In chronic toxicity, avoid fasting and take food 2 times regularly.
3	Regular bath
4	Massage
5	Consume Ghee
6	Practice sexual abstinence -Male should avoid coitus, sexual intercourse with female partner.

**Note-** Latin names of plants may be available from Ayurvedic pharmacopoeia of India, Part I. Sequence and number are for convenience and doesn't carry much logical significance.

Above treatment is to be continued to aim *Rasapaka lakshana*<sup>[26]</sup> mentioned below. Evaluation of prognosis of diseases and chance of mortality has been in ancient classics under the section like *Indriya sthana*.<sup>[27]</sup> One should titrate the dose duration of treatment considering several aspects like strength of patient, severity of toxicity, potency of medicine, type of medicine and combination of protocol. Single medicinal protocol might not sufficient and combination of protocols mentioned above should be chosen on the basis of presentation and severity of toxicity.

**Signs of completion of treatment of Mercurial toxicity (*Rasapaka Lakshana*)-**Regular normal movement and functioning of *Vata* in body i.e. regular normal bowel habit and movements, no nausea or vomiting, flatulence etc., regular normal urine, thirst and appetite and proper digestion. No deficit of any *indriya*<sup>[28]</sup> i.e. No sensory, motor, intellectual or mental or psychiatric deficit (no auditory, visual, taste, smell impairment. No gait imbalance, tremors, dysarthria, fatigability, irritability). Pleasant feeling or feeling of wellbeing. Signs of *Jirnaushadha* (properly metabolized administered medicine), signs of *jirnahara* (properly digested food), criteria of optimum *langhana* (fasting)<sup>[29]</sup> and *samyak bala* [(optimum strength) *shareera, manasika, vyadhi, Agni* etc], *swasthata* (health) has been mentioned in classics.<sup>[30]</sup>



## DISCUSSION

Chelating agents can be used to treat acute inorganic mercury poisoning. The chelation agents include very widely used D-penicillamine (DPCN), DMPS, and succimer (DMSA). Adverse effects of these agents include thrombopenia, leukopenia and nephrotic syndrome. These agents have to be used with care.<sup>[31]</sup>

Significance of review and research on Ayurvedic management of Mercury toxicity is that, in Ayurvedic therapeutics mercurials are frequently administered. They are advised to administer with following certain protocol (*kshetrikarana* etc) and patients are required to follow certain regime of do's and don'ts. To complicate this they are intentionally administered usually in diseased state and all signs of mercurial toxicity and its complications may also be coarse of such diseases or their complications.<sup>[32,33,34,35]</sup> Further inspite of administration of Mercurial in Rasaushadhi (mercury containing medicine) some what known form, biochemical characterization (form /nature in biological system) of mercurial form in different Ayurvedic mercurials given with different co-adjuvants is difficult to ascertain which is important as choice of treatment of mercurial toxicity differs as per form of mercury.<sup>[36]</sup>

Bhaishajya Ratnavali is latest text (written in 16<sup>th</sup> century AD) among other searched ancient texts in present research which is majorotically a treatment book. Administration of *Shuddha Gandhaka* has been given priority in the management of all complications of Mercury. Mercury has high affinity towards sulphur (thiol group,<sup>[37]</sup> sulphhydryl group),<sup>[38]</sup> hence may render mercurial to Sulphide form, biologically more safer form of mercury.<sup>[39]</sup> With metal ions, thiolates behave as ligands to form transition metal thiolate complexes.<sup>[40]</sup> DMPS (2,3 Dimercapto-1-Propanesulfonate); a sulphur compound has been found by a number of investigators to provide a reliable estimate of body burden, safer than British Anti-Lewisite and more potent than DMSA [75, 97–101] which upon administration converts to disulphide form.<sup>[41]</sup> Mercury is almost all times noticed treated pharmaceutically (*Muurchana, Bandha, Jarana*) to develop in to a medicinal formulation in Ayurvedic pharmacotherapeutics. Rock salt is noticed to used widely for management of its toxicity. It contains sodium sulphate, Pottasium sulphate, Hydrogen sulphide etc soluble sulphur compounds along with many water soluble trace elements, which may lead to formation of mercury sulphide and mercurial complexes inside body rendering it safe. Comparatively more hepatoprotective and neuroprotective effect of garlic administration in Animal study with administration of methyl

mercury as that of standard control and less toxicity of mercury in people consuming garlic, documented in previous clinical research<sup>[42]</sup> is due to its Sulphydryl compounds (S-S, S-H compounds) forming sulphur compounds with heavy metals in the body and promoting excretion of heavy metals through bile in feces.<sup>[43,44]</sup> Sodium and Chloride both ions have been seen to reduce mercurial toxicity. Sodium maleate<sup>[45]</sup> is proven antidote of methyl Mercury and the concomitant exposure to Cl<sub>2</sub> and Hg<sup>0</sup> effectively reduces worker exposure by decreasing the amount of airborne Hg<sup>0</sup> available for inhalation and absorption.<sup>[46,47]</sup> On the addition of a considerable excess of NaCl a marked prolongation of the survival time occurs, the maximum antagonistic effect being evident when the solution is approximately isotonic. Almost exactly the same result is obtained if the NaCl is replaced by quantities of glucose sufficient to effect equal changes in the osmotic pressure of the solutions, and thus the antagonistic action of the sodium chloride appears to be due to the physical, rather than the chemical, changes its addition brings about in the nature of the toxic solution.<sup>[48]</sup> Administration of *Saindhava*, *Sauvarchala lavana*, *Sajjikshara* and sugars like sugar, honey mentioned in Ayurvedic protocol might have similar mechanism of action (osmotic diuresis) along with others like formation of ligands, forced alkaline diuresis etc. Kshara possesses diuretic property. Co-administration of *Saindhava* may also facilitate diuresis leading to excretion of mercury out of body. Decoction of *Katuki* in the management of *Rasajirna* as well as in *kshetrikarana* enables hepatoprotection.<sup>[49,50,51]</sup> which is needed to maintain excretion through maintenance of hepatobiliary secretion which might get affected due to mercury toxicity. Bitter melon inhibits CYP 450 enzyme,<sup>[52,53]</sup> a common drug metabolizing enzyme, thus inhibiting metabolism of mercury present in serum and further deposition which helps in its renal and hepatobiliary excretion. The excretory half life of methyl mercury in man is about 70 days, with approximately 90% being excreted in stool. Some degree of enterohepatic circulation apparently occurs. Use of mild laxatives and caution to avoid and treat constipation may help in excretion of secreted mercury from body parts and blood into the Gastrointestinal system through fecal route.<sup>[54]</sup> Therapeutic emesis and purgesis may also serve the same purpose.

*Kitapatana* as a preparative measure of mercurial treatment may reduce chances of conversion of inorganic mercury to more toxic organic mercury (methyl mercury) by lower organisms like microorganisms,<sup>[55]</sup> parasites like Cestodes,<sup>[56]</sup> helminthes, nematodes (round worms, thread worms etc). Administration of multiple *Bhasma*, *shilajatu*, *Dhatubhasma* may provide trace elements and administration of *Rasayana* may correct multiple trace element, vitamin



deficiencies and reduce toxicity effect of mercury and other metals too.<sup>[57]</sup> Administration of trace elements and vitamins act as antioxidant and by scavenging reactive oxygen species, reduce oxidative tissue damage.<sup>[58]</sup>

Mercury toxicity adversely affects kidneys, nervous system, liver and gastrointestinal system, mucous membranes and leads to chronic renal failure, neurotoxicity [Central nervous system- Memory loss, schizophrenia, gait instability, tremors, dysarthria, paraesthesia, deafness and vision impairment, peripheral neuropathy(burning palms and soles) etc] and gastrointestinal disturbances (nausea, vomiting, bloody diarrhea, ulcerations in GIT) and various skin diseases. The drugs used for management possess Nephroprotective, hepatoprotective, neuroprotective, cardioprotective, memory enhancer, antioxidant, immunomodulatory properties etc. As per Ayurveda they are *Rasayana*, *vayahsthapana*, *Jivaniya*, *prinana*, *shramahara*, *Balya*, *Brumhana*, *Vishaghna*, *Deepana*, *pachana*, *aruchi-agnimandyaharahara*, *medhya*, *Tridoshaghna*, *vataghna* (few), *Raktashodhaka*, *Raktaprasadana*, *Tvachya*, *Netrya*, *mutrala*, *Vatanulomaka*, *mrudivirechana*, *malashaitihilyakara*, *virechaka*, *anulomaka*, *vranaropaka*, *Pittavirechaka* in action.<sup>[59,60]</sup>

Massage with *Vataghna taila* (Medicated oils like *Narayanataila*) may improve peripheral neuropathy and *Vataghna* treatment may arrest progression of neurotoxicity.

*Parada* contains *Visha* as *naisargika dosha* (inherent toxic property),<sup>[61,62,63]</sup> hence principle of administration of *Rasayana*<sup>[64]</sup> before administration of mercurial reduces chances of its toxicity. The properties of *Visha* and *Rasayana* are opposite to each other.

*Swarjikakshara* (Sodium bicarbonate), *Sauvarchala lavana* (krushna lavana containing NaCl, Soda Sulphide) may induce forced alkaline diuresis and thus help in excretion of mercury.

Some researches have been done on various natural agents, which clearly shows that they have potential in the form of some chemicals and molecules to remove toxicity caused by metals and minerals by any cause. These agents had already been practiced by ancient scholars.<sup>[65]</sup> Apart from these, as per contemporary researches drugs which are mentioned in Ayurveda for treatment of complications of *Rasavarga dravya* have been found effective in the management of mercurial toxicity these are-Garlic, Coriander, Boron etc. Few extracts or isolated compounds from such drugs or synthetic agents derived from these drugs or component of such drugs also have been found beneficial in its management like- NaCl,

Chloride, Thiols, proteins cysteine (N acetyl cystein), glutathione, Alpha lipoic acid,<sup>[66]</sup> trace elements (Zinc, potassium, Potassium citrate), organic functional groups like phenolics, ascorbic acid,<sup>[67]</sup> vitamin E, combination of Vit C and E,<sup>[68]</sup> etc.<sup>[69]</sup>

**Significance of general advice from Ancient classics of Rasashastra and Ayurveda) for management of Hg toxicity-** Cow's Milk contains cystein which have been studied for augmentation of Hg excretion and reversal of mercurial toxicity.<sup>[70]</sup> Sulfur containing amino acids contribute substantially to the maintenance and integrity of cellular systems by influencing cellular redox state and cellular capacity to detoxify toxic compounds, free radicals and reactive oxygen species.<sup>[71]</sup> Advice to avoid fasting in chronic poisoning may prevent constipation and facilitates excretion of Hg through feces on the other hand in case of acute poisoning, advice to fast may be due to corrosiveness, ulcerations and so as to facilitate excretion early by purgation. Ghee administration may be helpful in reduction of Hg deposition of nervous system and especially in brain as it can pass through Blood brain barrier and Hg has affinity to lipoidal tissue. Chelation has limitations in chronic neurotoxicity hence this protocol may be better option in such cases. In individuals with higher exposure or body burden, sweat generally exceeded plasma or urine concentrations and dermal excretion could match or surpass urinary daily excretion. Mercury levels normalized with repeated saunas in a case report.<sup>[72]</sup> Regular bath will remove Hg excreted via sweat and massage will enhance this process by increasing peripheral blood flow and reducing body burden and excretion through kidneys and liver thus reducing toxicity to these organs. Administration of decoction of excreta of buffalo may provide bile pigments. As Mercury combines with bile<sup>[73]</sup> hence excreted mercury in gut may get excreted more through feces by complexation with bile and with mild purgatives like *Haritaki* etc. *Katuki*, *Bhringaraja* like medicines helping in excretion of bile will also enhance its excretion. Advice to avoid sexual intercourse with female partner might have been given to avoid genotoxicity in known case of mercurial toxicity thus exclude chance of teratogenicity.

Apart from general instructions like bathing, massage etc and principles of management, like use of mild laxatives (*haritaki* etc), *pittavirechana*, strict observance of *Pathya*, *Apathya* and *Anupana* etc, administration of Cows milk, *Shuddha Gandhaka*, *Saindhava lavana*, *Gomutra*, bitter melon juice, lemon juice, decoction of *karkotaki*, *koshataki*, *Katuki*, *kanji* have been found advocated for the management of mercurial toxicity comparatively more frequently.

Thus above regimes not only may form ligands, sulphides of mercury and many mercurial complexes but help for physical expulsion of mercury from body, prevent different complications (manifestations) of mercurial toxicity. Principles used for management of mercurial toxicity and its classical method of administration, Principles and modules like *Dushi visha chikitsa*, *Bhakshana vidhana* or *sevana* including (*Kshetrikarana*, *Kitapatana*, *Panchakarma*, *Rasayana*), *Pathya*, *Apathya* and *Anupana* etc. during consumption of mercurial may be used for management of mercurial toxicity and they may open and explore new arena of management of mercury toxicity in present era.

## CONCLUSION

Ayurveda has unique concepts and several protocols of management of mercurial toxicity apart from contemporary principle of chelation and cleansing. The drugs mentioned in Ayurvedic classics and classics of Rasashastra for the management of mercurial toxicity are safer and few of them are scientifically proven beneficial. These principles of management and protocols have potential to prevent different complications (manifestations) of mercurial toxicity and principles used for its management and its classical method of administration may open new arena of management of mercury toxicity in contemporary age.

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