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RESEARCH ARTICLE

STUDY OF BIO MEDICAL WASTE IMPACTS ON ENVIRONMENTAL HEALTH IN MYSURU CITY, INDIA

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ABSTRACT

Clinical waste management system is a integrated procedure for monitoring, aggregating, assorting, accumulating, transporting, and discarding of clinical waste produced by an organization such as hospitals. Clinical waste constitutes various potential health and safety risks and hazards. In addition to their virulent and lethal features, the majorly unsteady and erratic nature of clinical waste streams has increased public concern about storage, treatment, transportation and ultimate disposal. The management of clinical waste is still in its genesis all over the nation. Today as of now, there is no substantial work done on medical waste management in several hospitals of Mysore city. Now, medical wastes are just mixed up with other domestic wastes and disposed crudely in municipal dumping sites. There is a lot of disorder along with plight among the operators, generators, and the general populace about the innocuous, uncontaminated management of clinical waste. This research paper finds environmental exposure and public health impact of poor medical waste treatment and disposal in Mysore city, based on several months of survey and finally proposes recommendations to the problems identified during the survey.

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INTRODUCTION

We believe medical institutions like hospitals are an omnipotent place to assist and to attend the patients. Subsequently hospitals that are known for the treating sick peoples were unaware about the damages to environment as a result of them. Today it is well established fact and a bitter reality that there are many adverse and harmful effects to the environment as well as human beings which are induced by the clinical waste produced during patient care. Clinical waste management system is a integrated procedure for monitoring, aggregating, assorting, accumulating, transporting, and discarding of clinical waste produced by an organization such as hospitals. A crucial component to the gross success of such a system is that it should be imperatively tackled with the vehemence on waste reduction rather than what has been termed as end-of-pipe impediments. This has several gains to the institutions, in addition to the community and the environment. One of the more obvious benefits is the minimization in costs associated with waste discard.

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The legal description of clinical wastes given by Ministry of environment and forest is as follows: "Biomedical Wastes" means solid, fluid or liquid waste encompassing its container and any intermediary outcome, which is generated during the detection, medication, therapy or vaccination of human beings or animal in investigation pertaining there to or in the production or testing biological and the animal waste from slaughter house or any other like establishment including the waste. The clinical wastes may be interpreted as discarded, redundant remnant materials emerging from health care enterprise. It has been depicted that around 85% of the hospital wastes are actually non-hazardous wastes, around 10 % are infectious waste and around 5% noninfectious but hazardous waste. In the current circumstances the treatment and discarding of clinical waste is turning to be a prime predicament in most of the nation's worldwide. Clinical waste constitutes various potential health and safety risks and hazards. In addition to their virulent and lethal features, the majorly unsteady and erratic nature of clinical waste streams has increased public concern about storage, treatment, transportation and ultimate disposal. A numerous studies and survey have suggested that the improper management and discarding of clinical wastes results in health perils to health workers who are most possibly directly exposed and to personnels and people near the facilities, in particular children and scavengers are more likely vulnerable to contagious wastes , in other words they have an elevated risk of getting diseases like hepatitis and HIV/AIDS (Adegbita *et al*., 2010; Coker *et al*., 2009, PATH, 2009; Oke, 2008; WHO, 2002, 1999). The World Health Organization predicts that every year there are about 8 to 16 million newly discovered events of Hepatitis B virus, 2.3 to 4.7 million occurrence of Hepatitis C virus and 80,000 to 160,000 instance of human immune deficiency virus (HIV) caused by precarious injections and especially because of very poor and inadequate clinical waste management systems (WHO, 1999; Townend and Cheeseman, 2005). In developing nations such as India, where various health cares are vying for constrained resources, it is not staggering that the control and organization of clinical wastes has got less consideration and the priority it deserves. Regrettably, pragmatic data and information on this important factor of healthcare management is deficient and research on the public health implications of ineffective management of healthcare wastes are few and limited in scope.

In India, clinical waste could varied from 15% to 35% based on the total integral quantity of waste produced as toxic waste (Glenn & Garwal, 1999; Anonymous, 1998; Chitnis *et al*., 2005). The management of clinical waste is still in its genesis all over the nation. Today as of now, there is no substantial work done on medical waste management in several hospitals of Mysore city. Now, medical wastes are just mixed up with other domestic wastes and disposed crudely in municipal dumping sites. There is a lot of disorder along with plight among the operators, generators, and the general populace about the innocuous, uncontaminated management of clinical waste. The rationality may be as result of absence of awareness. Consequently, resource material containing facts and figures on the environment for hospital administrators, surgeons, doctors, nurses, paramedical staff and waste retrievers, is the need of the hour (Almuneef & Memish, 2003; Acharya & Meeta, 2000). This research paper finds environmental exposure and public health impact of poor medical waste treatment and disposal in Mysore city, based on several months of survey and finally proposes recommendations to the problems identified during the survey.

MATERIALS AND METHODS

A Questionnaire was devised after discussion with the research guide. The main form was designed for clinical staff responsible for medical waste in each hospital. The questionnaire aimed at gathering information about the generation, segregation, collection, internal and external storage, transportation, treatment and disposal of medical waste in government and private hospitals in Mysore city. The key persons, the cleaners and sanitary workers were personally interviewed during May/September-2015 in order to collect additional information about the current practices in the medical waste management in Mysore city. The questionnaires were based on WHO model, and reformatted with modifications to be compatible to the organization of hospital facilities. The names of the private and governmental hospitals that have been surveyed are included in Table 1. The current research was conducted with an objective to determine the quantity of trace heavy metals in ash obtained from clinical waste incinerator of shree consultants.

Table 1. List of hospitals

S.No	Government Hospitals	Private Hospitals
1	Cheluvamba Hospital	JSS Hospital
2	K R Hospital	Columbia Asia Hospital
3	CSI Holdsworth Memorial Hospital	Narayana Hrudayalaya
4	E.D. Hospital	Apollo B G S Hospital
5	ESI Hospital	Gopalgowda Shanthaveri Memorial Hospital
6	PKTB & CD Hospital	Chithanya Maternity Hospital
7	Railway Hospital	JSS Dental College
8	Government Ayurveda Medical College and Hospital	Farooqia Dental College and Hospital
9	Central Hospital	I P P Maternity Hospital
10	ESI Clinic	Kamakshi Hospital
11	JSS Ayurveda Hospital	-
12	Jayadeva Institute of Cardio Vascular Science and Research	-

About 32 ash samples of each weighing around 5 kgs were drawn and dried at normal room temperature. All the overt metals and glass items were deposed; ash samples were traversed through several assorted mesh sieves. Entire samples were amalgamated with the help of a blender and the blended samples and specimens were taken for analysis. The Limits of Cu, Cr, Cd, Mn, Mg, Ni, Fe, Zn, Pb, Al, Ca, Co, Na, K, P metals were identified by Inductive Coupled Plasma - Atomic Emission Spectroscopy and Hg, As, Se and Sb were examined by Atomic Absorption Spectroscopy. A few grams of ash from each sample were taken for digestion in HNO_3 – HCl mixture to analyze several metals and nonmetals. Extraction Procedure toxicity test method was employed to find out the toxicity level of clinical wastes.

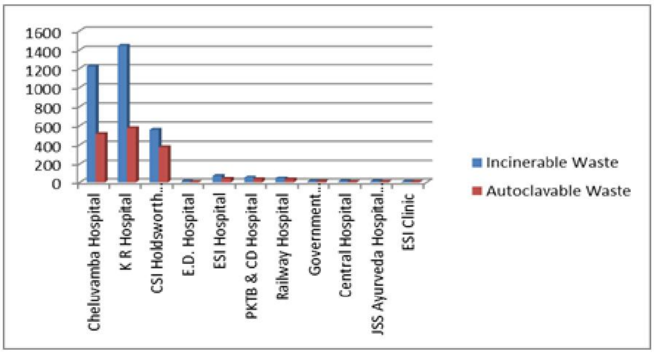
RESULTS AND DISCUSSION

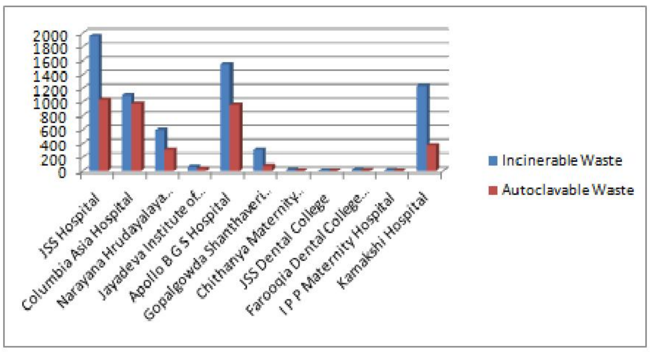
The research showed that the amount of general waste generated by 22 hospitals is about 15676 kg/month. The study indicated that the total medical waste generated is about 522.53 kg/day. The total medical waste generation rate for government hospitals is about 5021.10 kg/month, representing an average of waste generation rate of 2.5 kg/bed/month. While the total medical waste generation rate for the private hospitals is in the region of 10655 kg/month, giving an average of waste generation rate of 5.6 kg/bed/month the daily amount of medical wastes generated by each hospitals. Figures 1 and 2 represents clinical waste generated in hospitals. The amounts of the incinerable and autoclavable wastes produced by both government and private hospitals in Mysore are shown in following chart.

Heavy metals in Bottom ash

The bottom ash samples were examined for heavy metals concentration like Iron, Lead, Zinc, and Silver for four particles with respect to the particle size of bottom ash produced on the sampling day as shown in Figure 3-6. From these results, it was observed that the highest fraction metal was iron.

Figures 1and 2 shows clinical waste generated





It could be due to the fact that the main component of medical equipment such as needles, hypodermic needles, scalpel, blades and others, is iron. Moreover, the highest melting point of iron means the larger amount of its residues. Fractions of other metals were 1.5%, 0.04%, and 0.02% for zinc, lead and silver, respectively. From statistical analysis, it was found that the silver and zinc concentrations in bottom ash with respect to particle size were significantly different for four size ranges. For lead, the mass in the greater than 9.5 mm and 4.75-9.5 mm particle size rages were not significantly different, while for iron, the mass in less than 0.5 mm and greater than 9.5 mm were not significantly different.

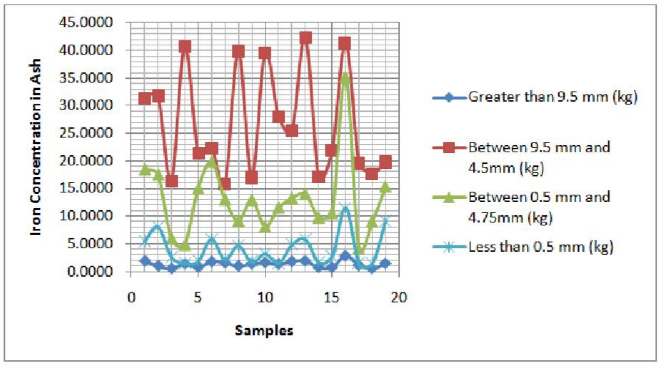


Figure 3. Iron concentration in ash

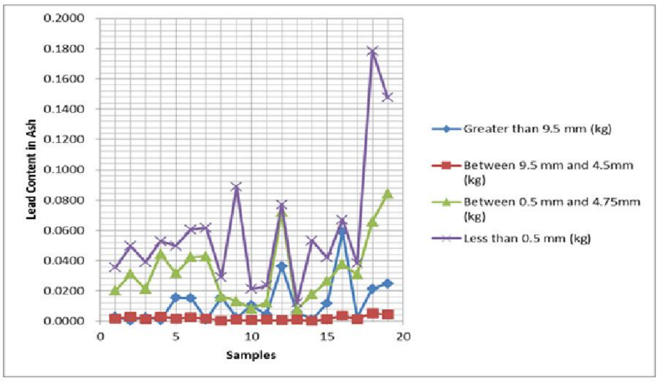


Figure 4. Lead concentration in ash

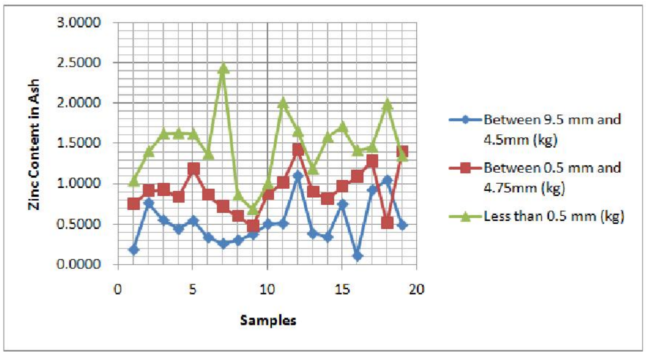


Figure 5. Zinc concentration in ash

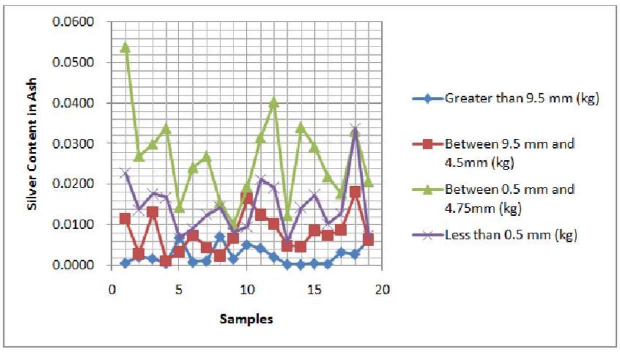


Figure 6. Silver concentration in ash

Figure 7. Ash Particle Size Less than 0.5 mm

Figure 8. Ash Particle Size between 0.5-4.75 mm

Figure 9. Ash Particle Size between 4.75 – 9.5 mm

Figure 10. Ash Particle Size Greater than 9.5 mm

EP Toxicity test

The tests of EP toxicity were carried out on modeled ash leachate samples in laboratory as per guidance for clinical wastes. The levels of heavy metals were examined in these samples with respect to particle sizes. Further information on results are given below. The iron levels in the samples from EP toxicity tests were found to be in the range of 1.5 to 5.9 mg/L. The zinc levels in the samples were in the range of 8.05 to 15.93 mg/L. The silver level in the samples tests were in range of 0.4 to 5.5 mg/L. The lead levels in the samples were found to be in range of 5.2 to 18.8 mg/L. The silver levels in the samples were in range of 0.4 to 5.5 mg/L. The relationship of heavy metals level with respect to the particle size is shown in Figure 11 to figure 14 respectively. The lowest concentration was in the class of lesser than 9.5 mm of particle size. The largest proportion was found to be in the class of 0.5 mm of particle size.

Heavy metals levels in modeled leachate were very low when compared to heavy metals in incinerator ash. Due to the fact that the leachability tests were carried out under laboratory conditions with the help of distilled water; Also, leaching of the heavy metals from incinerator ash can heavily raise if acidic solutions were used, which attempt to simulate acid rain conditions. Water in contact with bottom ash produced alkaline solutions rather than acidic ones. This made the heavy metals concentrations in bottom ash leachate much less than in bottom ash. The leachability of metals adsorbed on bottom ash particles is enhanced, since the heavy metals largely occur in the smallest size fraction and concentrated at or near the surface of the particle. The small particle size increases available surface area exposed to leaching. However, it had high Lead and Silver in general. Also from the data, Lead and Silver levels were larger than the standards. Hence, it was indicated that such a bottom ash should be classified to be hazardous at times, and is likely to have highly mobile constituents, which, if improperly managed, could impact groundwater.

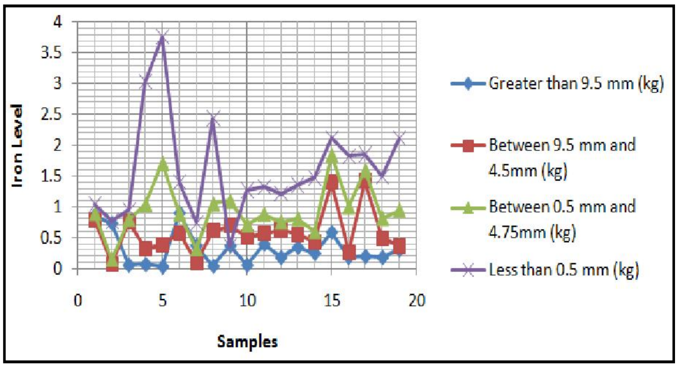


Figure 11. Samples Vs. Iron Concentration as in EP Toxicity Test

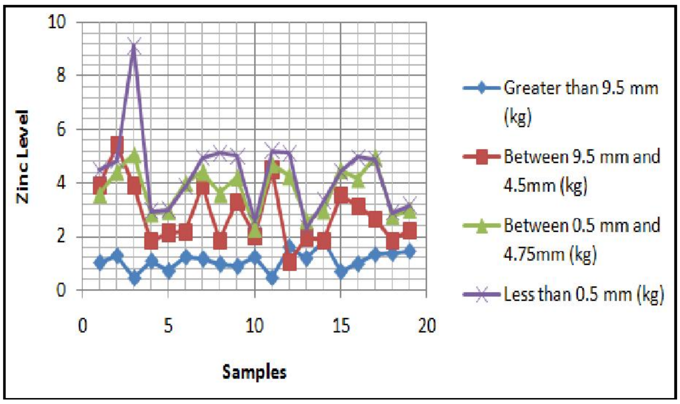


Figure 12. Samples Vs. Zinc Concentration as in EP Toxicity Test

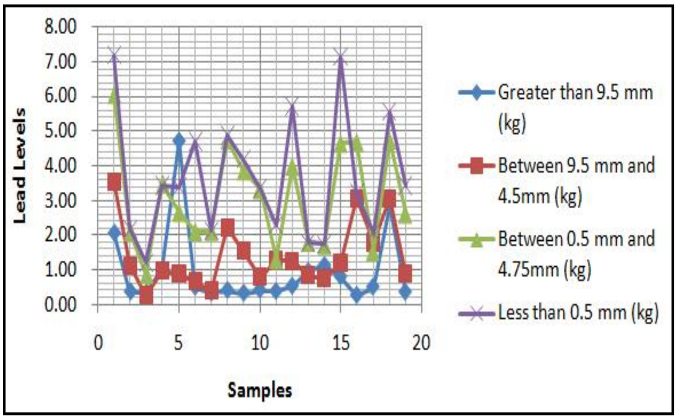


Figure 13. Samples Vs. Lead Concentration as in EP Toxicity Test

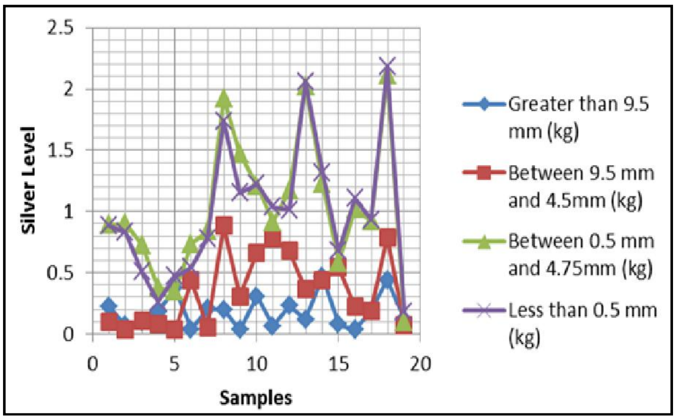


Figure 14. Samples Vs. Lead Concentration as in EP Toxicity Test

Table 2. The limits of detection for each element

Metals	Direct Aspiration		Actual Limit (µg/L)
	Detection Limit (mg/L)	Sensitivity (mg/L)	
Aluminum	0.1	1	-
Antimony	0.2	0.5	3
Arsenic	0.002	-	1
Barium	0.1	0.4	2
Beryllium	0.005	0.025	0.2
Cadmium	0.005	0.025	0.1
Calcium	0.01	0.08	0.03
Chromium	0.05	0.25	1
Cobalt	0.05	0.2	0.982
Copper	0.02	0.1	0.998
Iron	0.03	0.12	9.186
Lead	0.1	0.5	0.333
Lithium	0.002	0.04	-
Magnesium	0.001	0.007	-
Manganese	0.01	0.05	0.371
Mercury	0.0002	-	0.009
Molybdenum	0.1	0.4	1
Nickel	0.04	0.15	0.19
Potassium	0.01	0.04	0.02
Selenium	0.002	-	-
Silver	0.01	0.06	-
Sodium	0.002	0.015	-
Tin	0.8	4	-
Zinc	0.005	0.02	3.24

Conclusion

The toxic wastes have been examined in many studies. The concentration of heavy metals and elements varies according to the location of incinerator. The amount of zinc concentration is significant due to burning of teeth, bones and plastic material. The concentration of calcium, potassium and sodium is substantial in the animal experimental lab due to burning of animal carcass and bones/ teeth and kidney/ liver. The high concentration of lead in hospital and municipal waste incinerator samples is due to burning of considerable amount of plastic. Accurate disposal of bottom ash is consequently important to curtail environmental pollution. Using more sophisticated autoclaving/microclaving technologies is highly recommended. Land filling of incinerator residue is the best way of disposal, as the mobility of heavy metals inside landfill is very low. The complete wash out of metal may require thousands of years or more. Recycling may also be a way to reduce the loss of heavy metals to the environment. The proper disposal of incinerator ash would require regular analytical monitoring to ensure that the concentrations of trace elements are within permissible limits.

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