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Volume – 16 Issue – 01
September 2017

JOURNAL OF THE INDIAN SOCIETY OF HOSPITAL WASTE MANAGEMENT

HIGHLIGHTS

- **Situation Analysis of Biomedical Waste Management in an Indian District.**
- **Knowledge of Health Care Workers about BMW Rules 2016 provisions.**
- **Ontological framework for IEC for Biomedical Waste Management**
- **Checklist for evaluating BMW system in Health Care settings**
- **BMW in Dental Health Care settings – Summary of PhD Work**
- **Interns Page**
- **Other useful Information and Resources**

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INDIAN SOCIETY OF
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JOURNAL OF THE

Indian Society of Hospital Waste Management

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PRESIDENTS PAGE

1 Dec 2017

Friends,

The Indian Society of Hospital Waste Management (ISHWM) has been making rapid strides within and outside the country in the field of health care waste management. Many of you witnessed our last conference ISHWMCON 2016 at KMC, Manipal. Dr Somu, Dr Amitha Marla and team had worked hard to make it a grand success. It was during this conference that, we announced our next conference ISHWMCON 2017 at Bangalore. Prof Jai Prakash and Prof Ranganath of Academy of Certified Hazardous Materials Managers (ACHMM), India Chapter, Bangalore expressed their desire to hold it in close collaboration and under the aegis of ISHWM. I am happy to share with you that both ISHWM and ACHMM together with partners from M S Ramaiah Medical College, NIMHANS, UNIDO, KIMS and a few more put their best foot forward and worked hard by constituting various subcommittees and holding regular and frequent meetings. You can witness their hard work today at Bangalore. The popularity of ISHWMCON, a signature event of ISHWM, can be judged by the fact that a very prestigious and large institution has requested ISHWM to host the ISHWMCON 2018 after a year. The formal announcement to this effect will be made during ISHWMCON 2017 at Bangalore. All these conferences have been a big crowd puller of delegates and students from across the country. As regards the participation, the Mission Director NHM, Karnataka in association with UNIDO, Government of Delhi, DGAFMS (Doctors from Indian Armed Forces), KSPCB, CTFs, life members of ISHWM, students, scientists, engineers and likeminded delegates from other important institutions have sent their scientific papers and registered in ISHWMCON 2017. As President of ISHWM, I extend a hearty welcome to them. I take this opportunity to profusely thank the hosts and partner institutions to make this event a memorable one.

Besides conferences, your Society is also constantly working together with a number of institutions and hospitals to jointly hold CMEs/Seminars around the country on various issues related to BMW. During this year ISHWM and Safdarjang Hospital, New Delhi organized two such events, drawing large participation and very useful deliberations. These seminars focused on the challenges and grey areas in the BMW Rules 2016. The same are being brought to the notice of the policy makers. Besides, ISHWM is ready to provide consultancy services, be it auditing the HCFs, capacity building or improving and strengthening the HCWM in HCFs.
What ISHWM has contributed to IGNOU or WHO, SEARO is already highlighted in our previous issues. ISHWM also looks forward to collaborate with ACHMM an other bodies/organizations in related activities of mutual interest

I wish you all a great stay at Bangalore and ISHWMCON 2017 a grand success.

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EDITOR'S PAGE

Esteemed readers,

Cordial greetings from the Editorial team of Journal of ISHWM!

If we look back from the time before the BMW rules 1998 came into being in the country, there has been many positive and encouraging developments – India has become a signatory to Stockholm Convention in 2006, Common Biomedical Treatment facilities are in place in all States, segregation, disinfection, transportation within health care settings, transportation outside the health care settings are better, bar coding system has come to use in some places, newer treatment technologies are coming in, non-burn technologies are drawing attention and creating good systems are happening in many places. All these provide hope for developing good practices in life cycle approach for health care waste management.

Current issue contains article from a systematic study on Health Care Waste Management in a typical Indian District by Dr Ishfaq Nazeer Ahmad and a very exhaustive scholarly work by Dr K Pushpanjali throwing light on status in Dental Health Care systems. While article by Dr BS Nandakumar is a pioneering effort on Ontological frame work for IEC in HCWM, Intern's page is a new addition to the Journal.

Resourceful article by Dr Kamal Baghotia provides insights for creating better systems in health care systems, Article by Mr. Ramesh Gowda of EMPRI, GOK is a resourceful addition. Mr. Sharath provides input on references of recently available research, Dr Shankar from Vinayaka Mission , Salem draws our attention to useful You tube links. Dr. Ramakrishna Goud helps us with a useful check list in this issue.

I am grateful to President of ISHWM Dr AK Agarwal, past presidents and Members of Governing Council of ISHWM for the opportunity to serve as Hon Chief Editor of Journal of ISHWM since 2006. This would not have been possible without the support and encouragement of faculty and post graduate students of Dept of Community Medicine, Chairpersons of HCWM Cell Prof Dr C Shivaram and Prof Dr D Gopinath, Dr Medha y Rao, present Principal and Dean, MS Ramaiah Medical College, past Principals and Dean: Dr AC Ashok, Dr Saraswathi Rao, Dr S Kumar, Dr Sandhya Belawadi. My special thanks to Hon

Chairman Dr MR Jayaram, Dr BR Prabhakara, and Dr DV Guruprasdad past and present Chief Executives of Gokula Education Foundation, Bangalore. Dr N Girish Prof and HoD –Dept. of Epidemiology, NIMHANS, Dr Hemanth Thapsey –Registrar, M. S. Ramaiah Medical College and Dr V Narendranath –CAO, MSRMTH, Dr. Ramakrishna Goud, Professor & HOD, Community Medicine, SJMCH, Bangalore have been with me in this journey and I depended on them for many of my requirements.

Indeed, it is a joy to note that Journal of ISHWM Vol 16, No 1, September 2017 is being released on 1 December 2017 at the International Conference of ISHWM at Bengaluru. Apart from resourceful contributors, Dr Mounica, Dr Amulya PG students of our Dept and Ms Roopa –Desk officer ensured that I have all editorial and logistic support to bring out this issue. My immense thanks to them.

This Journal is the first of its kind dedicated to Health Care Waste Management in the Country and has potential to be indexed and more issues brought out every year. I request all readers and contributors to continue their support and patronage and ensure that the Journal grows further.

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ORIGINAL ARTICLE

SITUATION ANALYSIS OF MACRO AREAS OF BIOMEDICAL WASTE MANAGEMENT IN CHIKKABALLAPURA DISTRICT

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ABSTRACT

Background: It has been almost two decades since the implementation of BMW rules in India, but most Indian hospitals are yet to achieve the desired standards for BMWM practices.

Objective: To study the Macro areas (Policy, Authorization and renewal, Committee, Injury and Waste register) of biomedical waste management in healthcare facilities of Chikkaballapura district.

Type of study: Cross-sectional study

Study duration: Jan'2016 – Dec'2016

Methods: In all 67 HCFs were taken up for the study, 46 HCFs in private sector and 21 HCFs in the government sector. Pre-tested, semi- structured questionnaire was used to collect information. Information was collected on macro areas. SPSS version 18 Chicago was used for analysis.

Results: The data was tabulated and presented as percentage. Infection control policy or Hospital waste management policy was not present in any HCF. Overall 17(40%) in Private and 4(19%) in Government HCFs had obtained authorization and renewal from SPCB. In private sector, none of the HCFs was maintaining waste register in large, medium and small HCFs. In government sector, among large HCFs, waste register was present in 3(50%) HCFs and absent in the rest 3(50%) HCFs and injury register was not being maintained in any HCF in either private or government sector.

Interpretation and Conclusion: In the present study, the HCFs were found to be lagging in all aspects of Biomedical Waste Management, from Macro areas.

Key words: Biomedical waste management; situational analysis, Chikkaballapura.

INTRODUCTION

Managing of HCWs safely is of immense importance. According to BMWM Rules 2016, "bio-medical waste" means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps, including the categories mentioned in Schedule I of these rules.[2]

It is reported that between 75% and 90% of the waste produced by health-care providers is comparable to domestic waste and is usually called “non-hazardous” or “general health care waste”. It comes mostly from the administrative, kitchen and housekeeping functions at health-care facilities, and may also include packaging waste and waste generated during maintenance of health-care facilities. The remaining 10–25% of health care waste (HCW) is regarded as “hazardous” and may pose a variety of environmental and health risks.[3]

In 2002, a WHO assessment conducted in 22 developing countries showed, that 18% to 64% of healthcare facilities do not use proper waste disposal methods.[3] It has been almost two decades since the implementation of BMW rules, but most Indian hospitals are yet to achieve the desired standards for BMW management practices. Chikkaballapura is a newly carved out district from Kolar. There haven’t been many studies in the district to evaluate BMW management in the HCFs of the region. The study aims at exploring the current situation of healthcare waste management in terms of macro areas in the HCFs and make a comparison among the HCFs in private sector and government sector.

MATERIAL AND METHODS

Study unit: Health care facilities (in private & government sector) of Chikkaballapura district, Karnataka

Study design: Cross sectional study

Study duration: Jan’2016 – Dec’2016

Study instrument: The Questionnaire used is the study tool devised by Healthcare Waste Management Cell, Department of Community Medicine, M S Ramaiah Medical College.[4]

Part I: Included the general description of the HCFs Part II: Looked into the macro areas – Infection control Policy, Hospital waste management policy, Infection Control Committee (ICC), Hospital waste management committee (HWMC), Authorization and renewal, Monitoring and recording system.

SAMPLING METHODOLOGY

Complete enumeration of Large and medium HCFs in private and government sector was carried out. Probability proportion to size sampling method followed by simple random sampling using random number table was used to select small HCFs from both the private and government sector.

SAMPLING DESIGN

The study units were classified into Large, Medium and Small health care facilities according to bed strength. No sampling was done for Large and Medium HCFs. All such HCFs were included in the study. There were 7 HCFs in Public sector and 19 HCFs in Private sector.

For the small HCFs, the sample size was calculated based on INCLEN Program Evaluation Network (IPEN) study that they had done in 20 states of India.[5] In the said study, it was observed that Bio-medical waste score was lowest in 82 % of Primary (Small) health care settings. Applying the same estimates, with relative precision of 15 %, desired confidence level of 95 % and 10 % non-response rate for Chikkaballapura District, the sample size of small HCFs was estimated to be 41.

The description of study units and their classification is shown in the Table below.

Type of HCFs	**Number of beds**	**Private sector HCFs (N=123)**	**Public sector HCFs (N=62)**
LARGE	**> 50**	1	6
MEDIUM	**10 – 50**	18	1
SMALL	**<10**	104	55

Thus HCFs studied included 7 Large and 19 Medium HCFs. After sampling, 27 HCFs in private sector and 14 HCFs in government sector were included in the study.
Type of HCFs studied included, in private sector - 1 large hospital, 14 medium hospitals and 4 nursing homes, 1 small hospital, 17 clinics and 9 laboratories. In government sector - 1 District hospital, 5 Taluk hospitals and 14 Primary health centers were studied.

ETHICAL CLEARANCE

Ethical clearance from the M S Ramaiah Institution Review Board was obtained. Permission to undertake the study was also obtained from the District Health Office, Chikkaballapura. A written informed consent was taken from the management of the all the HCFs. All access to the data was restricted to the investigator alone.

STATISTICAL ANALYSIS

Data was entered on MS excel and was analyzed using SPSS version 18 Chicago. Descriptive statistics was used to summarize the quantitative variables like Injury register, waste register, etc. Data was tabulated according to sector wise distribution (Private and Government) and then based on type of HCF (Large, Medium and Small). Frequency and percentages were used for presentation and making comparison of study variables like healthcare waste management Policy, healthcare waste management Committee, authorization and renewal, etc across the sectors.

RESULTS

The study was conducted in 67 Health Care Facilities of Chikkaballapura District; 46 Health Care Facilities in the private sector and 21 in the Government sector. The results of the study are given below.

Table 1: Status on authorization and renewal of biomedical waste management from SPCB among the HCFs

Authorization and Renewal obtained from SPCB	Health care facility (HCF)					
	Private n= 46			Government n=21		
	Large n(%)	Medium n(%)	Small n(%)	Large n(%)	Medium n(%)	Small n(%)
Obtained	1(100.0)	16(88.9)	0	1(16.6)	0	3(21.4)
Not renewed	0	2(11.1)	10(37.0)	5(83.3)	1(100.0)	9(64.3)
Not obtained	0	0	17(63.0)	0	0	2(14.2)
Total HCFs	1 (100.0)	18 (100.0)	27 (100.0)	6 (100.0)	1 (100.0)	14 (100.0)

Overall 17 (40%) in Private and 4 (19%) in Government HCFs had obtained authorization and renewal from SPCB. 63% of small HCFs in private sector and 14.2% HCFs in government sector had not obtained authorization from SPCB.

Table 2: Distribution of Hospital waste management committee (HWMC) in private and government HCFs

HWM committee	Health care facility (HCF)			
	Private N=19		Government N=7	
	Large (1) n(%)	Medium (18) n(%)	Large (6) n(%)	Medium (1) n(%)
Separate committee present	0	1(5.5)	1(16.6)	1(100)
Part of ICC	1(100)	5(27.8)	5(83.3)	0
Not present	0	12(66.7)	0	0
Total	1(100)	18(100)	6(100)	1(100)

Hospital waste management committee was looked into among large and medium HCFs in private and government sector. It was observed that a separate HWMC was present in only 16.6% of large HCFs in government sector and in 83.3% of HCFs it was part of ICC. It was also observed that 66.7% of medium HCFs in private sector did not have Hospital waste management committee.

Table 3: Status of Waste Register and Injury register in private and government HCFs

Status of Waste register and Injury register		Health care facility (HCF)					
		PRIVATE N=46			GOVERNMENT N=21		
		Large n(%)	Medium n(%)	Small n(%)	Large n(%)	Medium n(%)	Small n(%)
Waste management	Absent	1(100)	18(100)	27(100)	3(50)	0	10(71.4)
	Present	0	0	0	3(50)	1(100)	4(28.6)
Injury Register	Absent	1(100)	18(100)	27(100)	6(100)	1(100)	14(100)
	Present	0	0	0	0	0	0

In private sector, no HCF was maintaining waste register in large, medium and small HCFs. In government sector, among large HCFs, waste register was present in 3(50%) HCFs and absent in the rest 3(50%). Among government medium HCFs, waste register was present. And among small HCFs of government sector, waste register was present in 4(28.6%) and absent in the rest of the HCFs. It was also observed that Injury register was not being maintained in any HCF in either private or government sector.

DISCUSSION

Table 1 shows that in our study the medium HCF in government sector had obtained authorization. It also revealed that authorization and renewal from State Pollution Control Board was least among small private HCFs. All the HCFs, especially the large and medium HCFs in both government as well as private sectors have to obtain authorization and renewal from the concerned State Pollution Control Board. A study done in a district hospital in Kodagu, revealed that the facility had availed authorization for Bio-medical waste. An annual report was submitted to Pollution Controlboard.[6]

Table 2 points out the need of having a Hospital Waste Management Committee / Infection Control Committee for the effective management of healthcare waste. The King George Medical University, Lucknow constituted a Biomedical Waste Management (BMWM) Committee in the year 2009. The Committee consists of the Head of the Institution, Chief Medical Superintendent, Financial Officer (FO), Registrar, Matron, Civil Engineer, Sanitary Inspectors, Heads of some clinical departments and a Member Secretary, who is the key person responsible for all the activities related to BMWM. A nodal officer from each departments was

made incharge of BMWM in the respective departments and would coordinate with the committee.[7]

Table 3 shows that in private sector no HCF was maintaining waste register. In government sector, among large HCFs, waste register was being maintained by half (50%) of them and among small HCFs, waste register was maintained in only 28.6 % of HCFs. Maintaining a waste register is essential in all HCFs to quantify the waste generated in the HCF so that a proper mechanism is devised for its effective management as per the BMWM Rules 2016. It was also observed that Injury register was not being maintained in any HCF in either private or in the government sector. There was no system of reporting injuries.In a study in District hospital, Kodagu, it was observed that a record is maintained of the waste generated in the wards.[6] In another study carried out by Pandit et al in a district of Gujarat on Management of Bio-medical Waste, it was observed that only 20% of hospitals have made a committee to look after the hospital waste, all were Government hospitals. Only two Government hospital doctors have attended seminar on bio-medical waste management. None of the hospitals had any record keeping system about amount of waste generation. They were not keeping record for injuries occurred to health personnel, during their routine work. None of the hospitals knew about authorization that they have to take from Pollution Control Board. They also didn't know about annual report submission to pollution control board.[8]

Thus there is a need of having an effective waste management practices in HCFs. Having a Policy on Health care waste management and Hospital Waste Management Committee / Infection Control Committee in large and medium HCFs as well as the presence and updating of Injury register and Waste register would be a positive step in the effective management of healthcare waste.

LIMITATIONS

1. Having a larger sample size would have helped in getting a better picture of biomedical waste management in the study area.
2. The quantum of healthcare waste generated in HCFs was calculated from the receipt obtained from CBMWTF. Manually weighing the healthcare waste would have ensured more accurate calculation of quantum of healthcare waste generated in HCFs.

CONCLUSION

The situation analysis of healthcare waste management was conducted among 67 HCFs from both private and government sectors in Chikkaballapura district. Majority of private healthcare facilities were present in urban areas and majority of government HCFs were present in rural areas of the district. As far as macro areas are concerned, none of the large and medium HCFs studied, had an Infection control policy or a Hospital waste management policy in place. Similarly half of the HCFs studied did not have a separate hospital waste management committee.

Even though a number of HCFs have not obtained Renewal of the Authorization from the State pollution control board, it was still observed that they would hand over the biomedical waste to the authorized Common Biomedical Waste Treatment Facility.

RECOMMENDATIONS

1. There is a need for Infection control policy and Hospital waste management policy, Infection control committee and Hospital waste management committee in large and medium HCFs.
2. All the HCFs must obtain authorization and renewal from State pollution control board.
3. Waste register and Injury register should be present in all the healthcare facilities and should be daily updated.

ACKNOWLEDGEMENT

Principal & Dean, Registrars, HoD, Faculty, Post graduates, MSWs and non teaching staff of Department of Community Medicine, M S Ramaiah Medical College, District Health Officer, The District Health Office, Chikkaballapura, Taluk Health Officers, Medical Officers of government healthcare facilities of Chikkaballapur district, Management of all the private healthcare facilities and all the staff of the healthcare facilities studied.

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ORIGINAL ARTICLE

EVALUATING AND COMPARING THE KNOWLEDGE OF HEALTH CARE WORKERS ABOUT LEGISLATION AND REGULATORY MECHANISM ON BIOMEDICAL WASTE MANAGEMENT IN A TERTIARY CARE MEDICAL INSTITUTE OF NORTH INDIA

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ABSTRACT

Context: Proper management of biomedical waste (BMW) is very essential from legal aspect as its improper management may put health care workers (HCWs) as well as owner of the hospital in trouble under sections 5 and 15 of Environment (Protection) Act, 1986

Aims: To assess and compare the knowledge of HCWs on legislation and regulatory mechanism on BMW management as applicable in India at time of study.

Settings and Design: This cross-sectional study was conducted in a tertiary care medical institute of North India.

Methods and Material: A researchers' made close-ended questionnaire was administered by personal interview to randomly selected 10 doctors, 10 staff nurses, 10 laboratory technicians and 10 sanitation supervisors/inspectors.

Statistical analysis used: Done by descriptive statistics. For comparison, ANOVA and Post Hoc tests were applied.

Results: It was found that the knowledge of doctors and laboratory technicians was significantly less than knowledge of staff nurses and sanitation supervisors (p value < 0.001). There was however no significant difference when knowledge of doctors and technicians was compared with each other (p value > 0.05) and similarly there was no significant difference when knowledge of staff nurses and sanitation supervisors was compared with each other (p value > 0.05).

Conclusions: It was concluded that regular teaching classes need to be held for doctors and laboratory technicians laying more emphasis on the legal aspects of BMW management.

Key-words: Biomedical waste, healthcare workers, legislation, regulatory mechanism

INTRODUCTION

Proper management of biomedical waste (BMW) generated in a health care facility is essential both from ethical as well as legal aspects. Its improper management may transmit diseases, degrade the environment and make authorities of health care facility liable for legal action. There are many pathogens which have been documented to be transmitted by improperly managed BMW, however the main concern for proper management of BMW is due to its propensity to transmit three viruses namely Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV) and Hepatitis C Virus (HCV) which are transmitted by infected sharps especially hypodermic needles. Worldwide, 8-16 million hepatitis B, 2.3 - 4.7 million hepatitis C and 80 000 - 160 000 HIV infections are estimated to occur yearly from re-used unsterilized injection equipments.[1] Besides, when BMW is not properly segregated, harmful chemicals namely Dioxins and Furans may be produced due to poorly controlled burning of chlorinated plastics in medical incinerators.[2]

Various studies have shown poor state of BMW management both nationally and internationally.[3-5] In India, the legal framework for BMW management was established on 20th July 1998 by promulgation of Bio-Medical Waste (Management and Handling) Rules, 1998 by Ministry of Environment, Forests and Climate Change, Govt. of India.[6] New rules replacing the rules of 1998 have been promulgated by Govt. of India on 28th March 2016 which are called as Biomedical Waste Management Rules, 2016.[7] Besides, guidelines for common biomedical waste treatment facilities and medical incinerators have been issued by Central Pollution Control Board (CPCB) of India[8,9]. There are various national and international studies in which knowledge of various categories of HCWs has been evaluated and compared regarding different aspects of BMW management including the legal aspects[10-15], but knowledge of HCWs exclusively on regulatory and legal aspects of BMW management has not been studied in these studies. The regulatory and legal aspects of BMW management are *per se* very crucial as they have the potential to put the owner and HCWs of a hospital in legal trouble under section 15 of Environment (protection) Act, 1986 and may also lead to closure of the hospital under sections 5 of the mentioned act[16].

Objectives: The present study was undertaken to assess and compare the knowledge of various categories of HCWs exclusively on regulatory and legal aspects of BMW management.

SUBJECTS AND METHODS

This cross-sectional study was done in a tertiary care public hospital of North India in the months of December 2015 to February 2016. A close-ended questionnaire was developed by researchers based on literature review. It contained ten questions covering various aspects of regulatory and legal framework governing BMW management in India at the time of study. Each question had four responses including only one correct response. A correct response was given 1 and incorrect as 0 mark. There was no negative marking. A HCW could get marks ranging from 0 to 10 and a category of HCWs could get maximum of 100 marks. Questionnaire was modified after pre-testing it in 2 HCWs of each category to ensure that the questions and responses are understood in proper perspective. These HCWs were not included in the final study group. After explaining the purpose of study and obtaining consent, the questionnaire was administered through interview to randomly chosen 10 doctors, 10 nurses, 10 laboratory technicians and 10 sanitation supervisors/inspectors.

Statistical analysis was done by descriptive statistics. For comparison, ANOVA and Post Hoc tests were applied.

RESULTS

There were 4 categories (Doctors, Nurses, Technicians and Sanitary Inspectors/Supervisors); each category comprising of 10 subjects or a total of 40 subjects across all categories.

Score of each category (Table 1)

Overall the Doctor category scored 43 marks (43%) with mean as 4.30; the Nurses category scored 80 marks (80%) with mean as 8.00; Technician category scored 40 marks (40%) with mean as 4.00 and Sanitary Inspector category scored 77 marks (77%) with mean as 7.70.

Seen in totality across all categories, the score was 240 out of 400 or 60% i.e. a mean score of 6.0 per HCW across all categories.

If score of 2 high scoring categories i.e. nurses and sanitary inspectors is taken together, it is found that they together scored 157 out of 200 marks, i.e. 78.5% or mean as 7.85.

Similarly, if score of 2 low scoring categories i.e. doctors and laboratory technicians is taken together, it is found that they together scored 83 out of 200 marks, i.e. 41.5% or mean as 4.15.

Comparison of score of categories (Tables 2 and 3)

The score of ‘Nurses category’ (80%) was significantly more than ‘Doctors category’ (43%) (p value < 0.001) and was also significantly more than ‘Technicians category’ (40%) (p value < 0.001).

Similarly, the score of 'Sanitary Inspectors' category (77%) was also significantly more than 'Doctors category' (43%) (p value < 0.001) as well as 'Technicians category' (40%) (p value < 0.001).

There was no significant difference in score between 'Nurses category' (80%) and 'Sanitary Inspectors category' (77%) (p value p > 0.05). Also, there was no significant difference in score between 'Doctors category' (43%) and 'Technicians category' (40%) (p > 0.05).

Overall score that each question got across categories

Overall question 1 (what is name of Rules currently applicable that govern management of bio-medical waste in hospitals?) got 11 incorrect responses and 29 correct responses; question 2 (to replace the BMW Rules 1998, which draft rules have been issued?) got 17 incorrect and 23 correct responses); question 3 (under which Act, the Bio-medical waste (BMW) Rules were promulgated?) got 17 incorrect and 23 correct responses); question 4 (what is the punishment prescribed for first offence/violation of BMW Rules?) got 20 incorrect and 20 correct responses); question 5 (under which section of Environment Act, a senior supervisory officer is saved of vicarious liability when his subordinate employee commits violation of provisions of BMW Rules?) got 23 incorrect and 17 correct responses; question 6 (under which section of Environment (Protection) Act, 1986, a hospital can be closed down for not managing its waste properly?) got 20 incorrect and 20 correct responses; question 7 (which is the prescribed authority for enforcement of provisions of BMW Rules?) got 11 incorrect and 29 correct responses); question 8 (what is the time period for which authorization is granted?) got 13 incorrect and 24 correct responses; question 9 (by which date, a hospital has to submit an Annual report related to BMW management to prescribed authority?) got 16 incorrect and 24 correct responses) and question 10 (to which authority, an accident related to BMW management that may occur in a hospital has to be reported?) got 12 incorrect and 28 correct responses.

Number of individuals in each category that gave correct response for each question (Fig. 1)

60% doctors, 90% nurses, 50% technicians and 90% sanitary inspectors gave correct response to question 1; 40% doctors, 80% nurses, 40% technicians and 70% sanitary inspectors gave correct response to question 2; 40% doctors, 80% nurses, 40% technicians and 70% sanitary inspectors gave correct response to question 3; 30% doctors, 70% nurses, 40% technicians and 60% sanitary inspectors gave correct response to question 4; 30% doctors, 60% nurses, 30% technicians and 50% sanitary inspectors gave correct response to question 5; 30% doctors, 80% nurses, 20% technicians and 70% sanitary inspectors gave correct response to question 6; 60% doctors, 90% nurses, 50% technicians and 90% sanitary inspectors gave correct response to

question 7; 50% doctors, 90% nurses, 40% technicians and 90% sanitary inspectors gave correct response to question 8; 40% doctors, 70% nurses, 40% technicians and 90% sanitary inspectors gave correct response to question 9 and 50% doctors, 90% nurses, 50% technicians and 90% sanitary inspectors gave correct response to question 10.

DISCUSSION

The study showed that the knowledge of nurses (80%) was more than all categories. At number two in knowledge was the sanitation supervisor/inspector category with score of 77%. Doctors and laboratory technicians scored 43% and 40% respectively.

More knowledge of nurses may be due to the fact that all nurses are imparted training on BMW management issues at the time of their induction. There are no formal teaching classes for sanitation supervisors at present. However, the department of sanitation is the nodal department to carry out most of the statutory obligations as mandated by the legal provisions such as initiating the process of renewal of authorization, submission of annual report to the prescribed authority and addressing various communications received from prescribed authority etc., due to which sanitation supervisors/inspectors are well conversant with the legal aspects of BMW management.

The low knowledge of doctors and technicians may be due to the fact that at present there is no regular schedule of formal training classes for them even though they are provided on-site teaching on various aspects of BMW management including legal aspects. These categories i.e. doctors and technicians also do not deal with any legal obligations for BMW management unlike the sanitation supervisors/inspectors. Besides, both doctors and technicians may be more concerned with their technical work i.e. clinical management of patients and carrying out laboratory investigations respectively and they may not be considering it necessary to be well conversant with the legal provisions stipulated in BMW management Rules.

There are various studies both at national and international level, in which knowledge of various categories of hospital personnel has been assessed on various aspects of BMW management. The knowledge score in these studies varies from very low (0%)[10] to very high (91.7%)[11].

A study conducted on knowledge, attitude and practices regarding biomedical waste management among the health care workers in a multispecialty teaching hospital at Delhi evaluated and compared the knowledge of 30 doctors, 30 nurses, 30 laboratory technicians and 30 sanitary staff. Study found that knowledge about legislative aspect of BMW Rules was poor

in the study group and overall it was 8.3%. Category wise, it was 20% in doctors, 10% in nurses, 3.3% in laboratory staff and 0% in sanitary staff[10].

Another study conducted in Allahabad, India found that 90.7% doctors, 91.7% nurses, 84.6% laboratory technicians and 25.7% sanitary staff had knowledge about BMW Management Rules[11].

In a study in Tehran, it was found that knowledge on healthcare waste management was good in 69.1% of hospital staff[14]. A study in Turkey found combined knowledge of 43.5% in health care personnel. The knowledge of doctors and nurses was more than other categories of hospital[17].

In most of the studies, doctors have been found to have higher knowledge score as compared to other staff of hospital. In a cross-sectional study conducted in Trivandrum, Kerala from December 2015 to March 2016, it was found that there was positive correlation between knowledge level and professional category. Knowledge was maximum in doctors and least in sanitation staff[18]. Similar results were found in other studies[11,15]. Unlike these studies, knowledge of doctors was less than nurses and sanitation supervisors/inspectors in our study. This may be due to the fact that in other studies, knowledge on all aspects of BMW management was assessed, but in our study knowledge exclusively on legal aspect was assessed. There is positive correlation between knowledge and practices and knowledge can be increased by training[13,14]. This study thus highlights that all categories of hospital staff especially the doctors and laboratory technicians should be systematically imparted training on BMW management with more emphasis on the legal issues related with BMW management.

Table 1. Descriptive Analysis of overall score of each category

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Doctors	10	4.30	1.767	.559	3.04	5.56	1	7
Staff Nurses	10	8.00	1.764	.558	6.74	9.26	4	10
Technicians	10	4.00	1.054	.333	3.25	4.75	3	6
Sanitary Inspectors	10	7.70	1.947	.616	6.31	9.09	5	10
Total	40	6.00	2.470	.391	5.21	6.79	1	10

Table 2. Comparison of number of correct responses amongst categories by ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Amongst Categories	137.800	3	45.933	16.503	.000
Within Categories	100.200	36	2.783		
Total	238.000	39			

Table 3. Multiple Comparisons with respect to correct responses amongst categories (Post Hoc Tests)

	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Bonferroni	Doctors	Staff Nurses	-3.700*	.746	.000	-5.78	-1.62
		Technicians	.300	.746	1.000	-1.78	2.38
		Sanitary Inspectors	-3.400*	.746	.000	-5.48	-1.32
	Staff Nurses	Doctors	3.700*	.746	.000	1.62	5.78
		Technicians	4.000*	.746	.000	1.92	6.08
		Sanitary Inspectors	.300	.746	1.000	-1.78	2.38
	Technicians	Doctors	-.300	.746	1.000	-2.38	1.78
		Staff Nurses	-4.000*	.746	.000	-6.08	-1.92
		Sanitary Inspectors	-3.700*	.746	.000	-5.78	-1.62
	Sanitary Inspectors	Doctors	3.400*	.746	.000	1.32	5.48
		Staff Nurses	-.300	.746	1.000	-2.38	1.78
		Technicians	3.700*	.746	.000	1.62	5.78

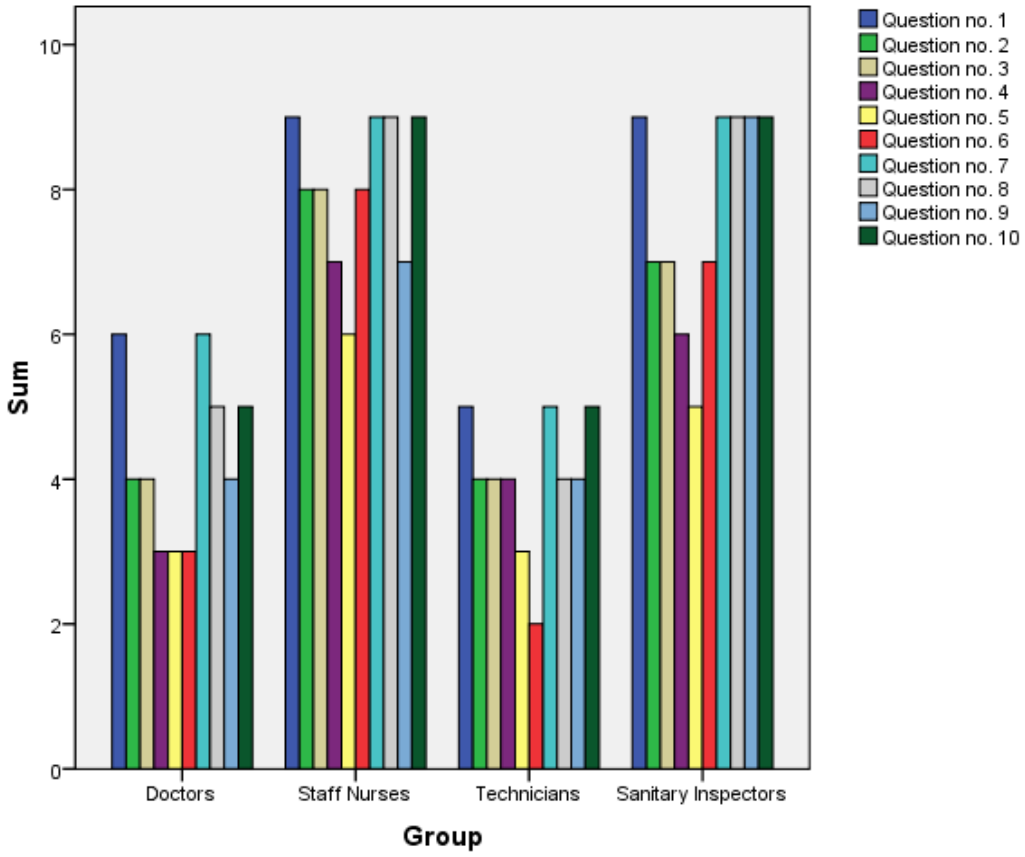

Fig. 1. Number of individuals in a category (group) that gave correct response for each question

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Box 1.1 Definitions of standards and guidelines Standards Standards are the requirements that must be met to achieve minimum essential environmental health conditions in health-care settings. They must be clear, essential and verifiable statements. Guidelines Guidelines are the recommended practices to achieve desirable minimum environmental health standards in health-care settings. They are not law, but should be used as guidance.

Source : WHO

ORIGINAL ARTICLE

AN ONTOLOGICALFRAMEWORK FOR INFORMATION, EDUCATION, AND COMMUNICATION (IEC)FOR BIO-MEDICAL WASTE(BMW) MANAGEMENT

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ABSTRACT

We present an ontological framework for information, education, and communication (IEC)for safe, efficient, and effective bio-medical waste (BMW). The frameworkdeconstructs IEC and BMW into three dimensions each. The seventh dimension is the stakeholders. Eachdimensionis articulated as a taxonomy of its consitutent elements Thus, the framework encapsulates the combinatorial complexity of information, education, and communication for bio-medical wastemanagement. It can be used to describe the domain's46,080potential components in natural English. Itcan help develop appropriate training and capacity building strategiesfor ensuring safe and sustainable management of bio-medical waste systematically and systemically, in contrast to the often simplified and selective approaches.It can be used to map availabletraining resources across the spectrum both nationally and internationally, discover gaps within and between countries, and develop a roadmap for the future.It can be scaled and extended as BMW managementevolves by adding dimensions, and extending/refining the taxonomies.

KEYWORDS: IEC, Bio-Medical Waste, Ontological Framework

INTRODUCTION:

Bio medical waste management is an important component of general waste management. The repercussions of improper management of bio medical waste affects both individuals as well as environmen. There has been considerable awareness regarding safe manamgnet of health care waste over the last few decades. As per the revised Bio Medical Waste Management Rules (2016), bio medical waste is defined as "any waste, which is generated during the diagnosis, treatment orimmunisation of human beings or animals or research activities pertaining thereto or in theproduction or testing of biological or in health camps, including the categories mentioned inSchedule I appended to these rules".(1)

Several studies have documented the impotance of imparting adequate training to all stakeholders for achieving behavioural change for positive health outcomes. Nutbeam et al have emphasised the need to consider the non-health components while developing training materials in health educational campaigns.(2)

In their article on establishing bio medical waste management systems Reema et al have emphasized the need for developing a robust training mechanism for engaging all stakeholders.(3) It is a well known fact that awareness and action are influenced by attitude to a large extent. While several studies have documented the knowledge of health care personnel for safe management of bio medical waste, there are huge gaps in applying the same for efficient practices. This is attributed to the gap in the training focussing on affective domain.

In this context, it is imperative that any taining material intendent to bring about behavioural changes should addrress all the three domains viz. cognitive, affective and psycomotor.

In order to adress the issue of not being selective while developing and implmenting various IEC activities a comprehensive ontology frame work has been developed.(4)

Information, Education, Communication				Bio-Medical Waste Management						
Level		**Medium**		**Domain**		**Systems**		**Stage**		**Outcome**		**Stakeholders**
Basic	[+]	People	[medium-focussing]	Cognitive	[aspects of]	Adminstrative	[systems for]	Segregation	[+]	Safety	[for]	Policy makers
Medium		Individual		Affective		Financial		Storage		Efficiency		Administrators
Advanced		Performance		Psychomotor		Technological		Transportation		Effectiveness		Health personnel
		Social				Social		Final disposal		Sustainability		Doctors
		Paper				Cultural						Nurses
		Film										Paramedics
		Internet										Staff
		Personal										Class IV emp.
		Social										CTF Handlers
		Virtual										Regulators
												Citizens

Fig 1: Ontology framework for IEC for Bio-Medical Waste (BMW) Management

An ontological framework for information, education, and communication (IEC) for safe, efficient, and effective bio-medical waste (BMW). The framework deconstructs IEC and BMW into three dimensions each. The seventh dimension is the stakeholders. Each dimension is articulated as taxonomy of its constituent elements Thus, the framework encapsulates the combinatorial complexity of information, education, and communication for bio-medical waste management. It can be used to describe the domain's 46,080 potential components in natural English.

According to the revised Bio Medical Waste Management Rules (2016) it is mentioned in Section: 14. Maintenance of records.- (1) Every authorised person shall maintain records related to the generation, collection, reception, storage, transportation, treatment, disposal or any other form of handling of bio-medical waste, for a period of five years, in accordance with

these rules and guidelines issued by the Central Government or the Central Pollution Control Board or the prescribed authority as the case may be; Section: 15. Accident reporting.- (1) In case of any major accident at any institution or facility or any other site while handling bio-medical waste, the authorised person shall intimate immediately to the prescribed authority about such accident and forward a report within twenty-four hours in writing regarding the remedial steps taken in Form I. Additionally Section: 13. Annual report.-(1) Every occupier or operator of common bio-medical waste treatment facility shall submit an annual report to the prescribed authority in Form-IV, on or before the 30th June of every year. In this context, all the stakeholders in the system are required to be adequately trained and instructed to undertake best practices in accordance with the rules.

The challenges in this complex task is the differeing levels of understanding as well as requirements of the various stakeholders. Not all of them may be adept at receiveing or using the knowledge provided for safe mangment of bio medical waste. Also the effectiveness of various media on different domains are varied. In this context choosing the appropriate combination of media, content addressing a particular domain for a particular stakeholder is of utmost importance.

The frame presented in this paper attempts to provide the users 46,080 potential components in natural English for either writing the objectives for generating IEC training materials or assessing the existing materials.

This would help in understanding the gaps in the contents available for traning and capacity buidlng in the area of bio medical waste.

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ORIGINAL ARTICLE

MY PERSPECTIVE ON HOSPITAL WASTE MANAGEMENT

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Hospital waste is very different from the ordinary waste that is produced in our homes on a daily basis that is why we need to adopt certain different methods for disposing off the hospital waste materials. Various complex substances are involved when it comes to the hospital waste. Hospital waste management is one of the prime concerns of medical authorities as well as concerned government bodies in different countries. Health care wastes are all the accumulated wastes generated in health care establishments, research facilities, laboratories and so forth. Even health care operations conducted in homes can result in generation of hospital wastes.
Rationally we should know the reason that why this management is so vital:

- Injuries from sharps leading to infection to all categories of hospital personnel and waste handler.
- Nosocomial infections in patients from poor infection control practices and poor waste management.
- Risk of infection outside hospital for waste handlers and scavengers and at time general public living in the vicinity of hospitals.
- Risk associated with hazardous chemicals, drugs to persons handling wastes at all levels.
- "Disposable" being repacked and sold by unscrupulous elements without even being washed.
- Drugs which have been disposed of, being repacked and sold off to unsuspecting buyers.
- Risk of air, water and soil pollution directly due to waste, or due to defective incineration emissions and ash.

There are certain approach being used in this waste management

Segregation of waste

Segregation is the essence of waste management and should be done at the source of generation of Bio-medical waste e.g. all patient care activity areas, diagnostic services areas, operation theatres, labour rooms, treatment rooms etc. The responsibility of segregation

should be with the generator of biomedical waste. The biomedical waste should be segregated as per categories mentioned in the rules.

Division of waste

Different categories of waste materials are divided into diverse sections so that they can be treated accordingly. It is a very important step that should be carried out at the place where the waste is generated. This activity should be carried out at diagnostic services areas, labour rooms, operations theatres, activity areas. Hygiene should be maintained at all time while treating the waste materials.

Transportation of waste

Once the waste is divided into the various different categories the next category involves the transportation of the waste matter from the place of origin to the place of decomposition. Bio-medical waste that is obtained from the hospitals should be treated separately and should never be mixed with the general waste. This reduces the chances of any disease.

Treatment of the hospital waste

The first step involves disinfecting the waste matter so that it no longer remains harmful for the human health. After disinfecting the waste the volume of waste should be reduced with the help of an efficient trash compactor. The waste matter should also be made unrecognizable so that it can be decomposed without any difficulty. The waste that can be recycled should be treated for further use.

Safety measures

Certain important safety measures should always be adopted while treating the waste. Waste which is of infectious nature can be very harmful for the environment and human health that is why measures would be taken for the prevention of any type of disease. Written instructions should be provided to all the people who are handling the hospital waste at the different stages of disposal. The management should be very careful and strict guidelines should be followed at all times without any fail.

The proper disposal and management of the Hospital waste is of utmost importance. It is required for the prevention of spread of diseases borne by hospital waste.

ORIGINAL ARTICLE

COLOUR CODE BASED OBSERVATION CHECKLIST FOR ASSESSMENT OF BIO MEDICAL WASTE SYSTEM IN HEALTH CARE SETTINGS.

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Part A: Macro Systems

Checklist for Assessment-Color Code based segregation of Bio Medical Waste in Departments (Wards, Phlebotomy sections, laboratories etc.)

Sl No	Colour Coding	Mention any one item found in container	Colour coded polythene liners	Segregation	Containment	Disinfection	Disfigure /Mutilation	Transportation	Storage	Final Disposal @ CBWMTF
1	**YELLOW-Soiled waste**		Yes / No	C/ P / US/ WS	A / IA	A /I A/ NA	NA	A / IA	A / IA	A / IA
2	**YELLOW-Pharmaceuticals**		Yes / No	C/ P / US/ WS	A / IA	A /I A/ NA	NA	A / IA	A / IA	A / IA
3	**YELLOW-Cytotoxic drugs**		Yes / No	C/ P / US/ WS	A / IA	A /I A/ NA	NA	A / IA	A / IA	A / IA
4	**RED**		Yes / No	C/ P / US/ WS	A / IA	A /I A/ NA	A / IA/ NA	A / IA	A / IA	A / IA
5	**WHITE-Puncture Proof Container (PPC)-Metal sharps**		Yes / No	C/ P / US	A / IA	A /I A/ NA	A / IA/ NA	A / IA	A / IA	A / IA

6	**WHITE-Puncture Proof Container (PPC)-Glass sharps**		Yes / No	C/ P / US	A / IA	A /I A/ NA	A / IA/ NA	A / IA	A / IA	A / IA
7	**BLUE Kg Cardboard-Metal implants**		Yes / No	C/ P / US/ WS	A / IA	A /I A/ NA	A / IA/ NA	A / IA	A / IA	A / IA
6	**BLUE Kg Cardboard-Glassware**		Yes / No	C/ P / US/ WS	A / IA	A /I A/ NA	A / IA/ NA	A / IA	A / IA	A / IA
7	***BLACK***		Yes / No	*C/ P / US/ WS*	*A / IA*	*NA*	*NA*	*A/IA*	*A / IA*	*A / IA*
8	***GREEN***		Yes / No	*C/ P / US/ WS*	*A / IA*	*NA*	*NA*	*A/IA*	*A / IA*	*A / IA*
9	***Food Waste***		Yes / No	*C/ P / US/ WS*	*A / IA*	*A /I A/ NA*	*A / IA/ NA*	*A / IA*	*A / IA*	*A / IA*
10	***General Plastic Waste***		Yes / No	*C/ P / US/ WS*	*A / IA*	*NA*	*NA*	*A / IA*	*A / IA*	*A / IA*
11	**other**									
12	**other**									

Note*: CBMWTF-Common Bio Medical Waste Treatment Facility*

Key pointers for assessing:

- ✓ **C-** Complete Segregation: is, only when biomedical waste items belonging to specified categories are found in a particular colour coded container
- ✓ **P-**Partial Segregation: is, when along with biomedical waste items of specified categories are found in a container of colour coding meant for other wastes
- ✓ **US-**Unsatisfactory Segregation: is, when there is mix of biomedical waste of more than two categories with or without mixing of food waste or general municipal solid waste.
- ✓ **WS-**Waste Sharps . Note that waste sharps cane be segregated to metal and glass sharps seperately.

- ✓ **A-** Appropriate
- ✓ **IA-** In Appropriate
- ✓ **Kindly note**:

  a. Wherever there is mix of waste sharps, the same needs to be described in detail.

  b. **Also please mention the method of Disposal for each of the categories (Ref Sl no 1 to 10 in table) if the health care facility is not linked to CBMWTF**.

Guidance for assessment:

- ➢ **Yellow Container**: Anatomical waste, Animal body parts, Placenta, tissue, Microbiology cultures, Sanitary napkins, Baby diapers, Cotton.
- ➢ **Yellow Containers(s):** Pharmaceutica waste- Separate Yellow Container for Non Cytotoxic pharmaceutical and Cytotoxic pharmaceutical waste
- ➢ **Blue Containers**: Separate for Glass waste and Discareded Metal impants in thick KG Cardboard boxes with blue colour code.
- ➢ **Red Container**: Medical plastic items, Blood bags, Urine bags, Syringes without needles, Plastic IV bottles, Plastic IV Lines, Gloves
- ➢ **PPC-White translucent** Container: Metal sharps-Injection needles, Suturing needles and Glass sharps-Broken ampoules, Broken vials, Glass slides
- ➢ **Expired drugs:** Kindly observe/enquire and note the practice
- ➢ **Glass IV bottles**: Kindly observe/enquire and note the practice.
- ➢ **Look for Labelling, Stencilling, Bio Hazard symbols, Cytotoxic drugs, Tags/tagging, Bar code system, Quantifying waste, Injury recording and reporting system – Observe and post observation ask questions for clarification and make notes of the same.**

  Part B: Sub systems

Sl No	Colour Coding	Labelling	Biohazard symbol	Tag	Barcode	Quantification /Weighment Record
1	**Incinerable Waste: YELLOW**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
2	**Pharmaceutical waste: YELLOW**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
3	**Cytotoxic Pharmaceuticals: YELLOW**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
4	**Plastics from Blood bank: RED**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
5	**Plastics from Microbiology Labs: RED**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
6	**Puncture Proof Container (PPC)**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
7	**WHITE BAG**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
6	**Glass Waste: BLUE Kg Cardboard**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
7	**Metal Implants and others: BLUE Kg Cardboard**	Present / Absent	Present / Absent	Present / Absent	Present / Absent	Present /Absent
8	***BLACK***					
9	***GREEN***					
10	***Food Waste***					
11	***General Plastic Waste***					
12	***other***					
13	***other***					

ORIGINAL ARTICLE

SUGGESTED SEGREGATION AND COLOUR CODING NORMS FOR MANAGING HOUSEHOLD WASTE GENERATED AT BULK GENERATION SETTINGS AND INDIVIDUAL HOUSEHOLDS

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INTRODUCTION AND BACKGROUND:

The waste generated at households predominantly fall under the purview of Municipal Solid Wastes (Management and Handling) Rules, 2000. However certain items that get generated at household/homes need special handling such as sanitary napkins, expired drugs/medicines, batteries, electronic and electrical wastes. The specific management of the same are mentioned in Bio Medical Waste Rules 2016, E-Waste Management Rules 2010 and Solid Waste Management Rules 2016 (Rules).

This guidance note is prepared for use by Citizen Groups, Residential Welfare Associations, NGOs and Municipal authorities for engaging in an informed discussion and dialogue concerning various options that could be considered for sound management of waste(s) with concerned government authorities and or waste management service providers.

It is suggested that the stakeholders/committees advocating and wanting to implement waste management systems, review the above mentioned Rules for information and more clarity and further a consultation with the local Environmental Officer (EO) of the Pollution Control Board (PCB) would help this cause. The EO of PCB can be met up with this document after the concerned stakeholders/team review the content for information and vetting by the implementing agencies (for example., PCB).

The objectives of General Solids Waste Management (Municipal waste) are;

To comply with the local government rules and/or legalisations concerning the wastes.

1. To safe guard health and environment by creating litter free lines and communities.
2. To enable sustainable environmental management by realising resource recovery and reuse of wastes by enabling composting, recycling and waste reduction.

Table 1: Colour codes and waste categories along with waste items generated at household level and their management

Sl	Colour Code	Waste Items	Processing/Final disposal
1	Green	Only Bio degradable waste like Food leftovers, flowers, banana/plantain leaves/foliage/leaves. *This waste must not be mixed with either paper, metal, plastic or glass*	In-house or On-site or On-location composting
2	Blue	Plastics and only plastics. Thick or thin plastics of any microns (thickness). Examples of commonly generated plastic waste in lines are milk sachets, pearl pet or soft drink bottles and polythene bags. Empty medicine plastic bottles can also be contained in this container. *This waste must not be mixed with either paper, metal or glass*	Identify a local plastic waste recycler with the assistance of the local Environmental Officer of the Pollution Control Board.
3	Red	Glass waste such as broken or discarded mirrors, glass panes. Fused Bulbs, tube lights. Empty medicine glass bottles can be contained along with this waste. Workers should be encouraged to keep these fused items intact. They should be asked not to break/damage the fused bulbs and tube lights as it unnecessarily generates glass sharps and makes it difficult in further handling for management.	Identify a local glass waste recycler with the assistance of the local Environmental Officer of the Pollution Control Board. *Please note that E waste Management Rules 2010 have prescribed norms for managing wastes such as fused bulbs, electrical and electronic gadgets including mercury based batteries.*
4	White	Metal waste, aluminium waste or any other metal ware. Used and waste pressurised canisters, such as spray/deodorants, pain killers, medical inhalers such as	Handed over to a local *kabadiwala/waste recycler. It is suggested that for this category as*

		those used for asthma patients can be contained along with this waste.	*well the local Environmental Officer attached to PCB can be consulted or informed.*
5	Puncture Proof plastic container	Only hazardous waste such as metal sharps, pins, injection needles, shaving razor blades including household batteries used for electronic gadgets/torch lights etc. However, individual household must contain these items in two separate containers to enable picking up battery waste by recyclers. In bulk generating settings, the same may be contained/collected at a single location.	Link this waste to Common Bio Medical Waste Treatment Facility (CBMWTF) operator. This waste needs to be disposed by landfilling.
6	Yellow	Sanitary pads/napkins, Diapers, condoms, expired drugs in the form of capsules, powders, tablets in aluminium or blister packs BUT NOT in plastic or glass bottles and no canisters or inhalers or any other pressurised containers.	An attempt must be made to link this waste to CBMWTF operator. The empty drug bottles (plastic or glass) and medicines in canisters must be managed as explained above.
7	Black	Paper/ thick paper based packaging material/Kg-cardboard waste. Not to be mixed with plastics or metals or glass	Handed over to a local *kabadiwala/waste recycler*

ORIGINAL ARTICLE

SYSTEMS APPROACH IN BIOMEDICAL WASTE MANAGEMENT

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SUMMARY

This article addresses the Role of a systems approach and to understand the reduction of the adverse impacts related to human health and environment. It examines the existing situation of Bio-medical waste management which is a serious concern in India. Moreover, smaller facilities such as Community Health Centres and Primary Health Centres are widely dispersed throughout the country thereby increasing the risks in the absence of environmentally sound management. These facilities lack the requisite standards and procedures for waste management. In the absence of treatment, poor handling practices and rudimentary methods for disposal, there are adverse effects on public health and environment. This article focuses on need of systems approach in biomedical waste management. The regulations in India has started in 1992 with special focus on Biomedical waste (Management and Handling) Rules 1998. These rules were further amended in 2003 and 2016. Interventions by prescribed authority are necessary in order to achieve environmentally benign behaviour. The government has a key role in collaborating with the stakeholders involved in health-care waste management as well as changing behaviour through regulation and increasing the level of awareness. Once system is established in an Institution, the biomedical waste will treated and disposed of in a scientific manner without harming human health and environment.

ABBREVIATIONS

- APCD - Air Pollution Control Device
- BMWM Rules - Bio-medical Waste Management Rules
- CBWTF - Common Bio-medical Waste Treatment and Disposal Facility
- CO - Carbon Monoxide
- CO2 - Carbon Dioxide
- CPCB - Central Pollution Control Board
- CRZ - Coastal Regulation Zone
- DG - Diesel Generator

- EC - Environmental Clearance
- EIA - Environment Impact Assessment
- ETP - Effluent Treatment Plant
- GPS - Global Positioning System
- HCFs - Health Care Facilities
- HCl - Hydrochloric Acid
- HOWM & TM Rules - Hazardous and Other Waste (Management & Transboundary Movement) Rules, 2016
- MHz - Mega Hertz
- MoEF& CC - Ministry of Environment, Forest & Climate Change
- KM - Kilometer
- KW - Kilowatt
- MoU - Memorandum of Understanding
- NABL - National Accreditation Board for Testing and Laboratories
- NOx - Oxides of Nitrogen
- O2 - Oxygen
- PCC - Pollution Control Committee
- PLC - Programmable Logical Control
- SEIAA - State Environment Impact Assessment Authority
- SLF - Secured Landfill
- SPCB - State Pollution Control Board
- TSDF - Treatment Storage and Disposal Facility
- TOC - Total Organic Carbon
- VOCs - Volatile Organic Compounds

INTRODUCTION

As per the Bio-medical Waste Management Rules, 2016 (hereafter referred as BMWM Rules) it restricts occupier for establishment of on-site or captive bio-medical waste treatment and disposal facility, if a service of Common Bio- Medical Waste Treatment and disposal facility is available within a distance of seventy-five kilometre, as installation of individual treatment facility by health care facility (HCF) requires comparatively high capital investment. The concept of CBWTF not only addresses such problems but also prevents proliferation of

treatment technologies in a town or city. In turn, it reduces the monitoring pressure on regulatory agencies. By running the treatment equipment at CBWTF to its full capacity, the cost of treatment of per kilogram bio-medical waste gets significantly reduced. Its considerable advantages have made CBWTF popular and proven concept in most part of the world.

The Major components of waste management systems approach are:

1. **Generation**
2. **Accumulation/ Segregated Collection**
3. **Handling**
4. **Storage**
5. **Transport**
6. **Treatment**
7. **Disposal**

Health care Waste management is 80 % segregation and 20 % technology.

<u>On site Management</u>

On site management should ideally have a system in place which when set up can effectively manage the health care waste disposal system smoothly. A system can be set up with this fact in mind which will be the foundation of onsite Health care

Before the actual disposal of waste, there should be a system for pre treatment of waste. It is the duty of the Occupier or the Generator of healthcare waste to not only ensure the disposal but also to ensure the Pre-Treatment of the laboratory waste, microbiological waste, blood samples and blood bags through disinfection or sterilisation on-site in the manner as prescribed. Although the most essential part of hospital waste management even before the pre-treatment is the segregation of Bio-medical waste. The segregation of the waste should be performed within the premises of the hospital/nursing homes. The colour coding, type of container to be used for different waste category have been dealt in later paragraphs and it has been mentioned about the new categories as per BMWM rules 2016 in India.

PRE TREATMENT OF BIO MEDICAL WASTE

What is Pre-treatment of HCW – Pre-treatment is the method of reducing or eliminating the contaminants of health care waste or altering its nature before being sent for final disposal.

Important Points-

- *There will be no chemical pre-treatment before incineration, except for microbiological, lab and highly infectious waste.*

- *Chemicals treatment to be done using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfections.*
- *Mutilation/shredding must be such so as to prevent unauthorised reuse*.

Pre-treatment procedures are

a. Use of Chemicals (reagents)
b. Thermal (by autoclave) and
c. Physical (mutilation)

Here are the Category wise pre-treatment procedures:

Mutilation of plastics and sharps- To prevent reuse of plastics and sharps, mutilation is required on-site before transportation to CBWTF

Discarded medicines (cyto-toxic drugs and antibiotics)- Cytotoxic wastes including all items contaminated with cytotoxic drugs are put in a non-chlorinated yellow container, which is mandatorily sealed and labelled as cytotoxic.

- Expired cyto-toxic drugs are returned to the manufacturer or supplier for incineration at temperature > 1200°C.
- No chemical pre-treatment is required in these cases.
- The antibiotic and other drugs are discarded in yellow bag with biohazard label. Dilution in water and discharge into a sewer for solutions containing vitamins, cough syrups, IV solutions and eye drops, salts, amino acids is deemed sufficient.

Liquid chemical waste:

Liquid waste generated due to the use of chemicals in production of biologicals, used or discarded disinfectants, infected secretions, aspirated body fluids liquid from laboratory, labour room, operation theatre, floor washings, cleaning, housekeeping and disinfecting activities should be collected separately and directed to effluent treatment plant (ETP). Prior to that the infected body secretions such as blood and faeces should be pre-treated and then disposed of in ETP.

Pre-treatment for faeces or vomit during an outbreak such as cholera involves decontamination with lime milk (hydrated calcium oxide or calcium hydroxide) – ratio of 1:2 for stool and vomit with lime for 6 hours minimum; ratio of 1:1 for urine with lime for 2 hours minimum.

Laboratories:

The blood sample glass vials or broken or discarded and infected glass need to be disinfected/autoclaved, (pre-treatment), wherever applicable and then packed in cardboard boxes with plastic liner with blue-coloured marking and sent to CBMWTF for autoclaving or microwaving for final recycling.

The non-infected glass does not need on-site pre-treatment.

Microbiology, biotechnology waste and infectious waste:

Laboratory waste including microbiology laboratory cultures, stocks or specimens of microorganisms and infectious waste of patients in isolation have to be pre-treated on site by autoclaving in an autoclave safe plastic bags or containers as per the WHO guidelines and there after sent for final disposal of autoclaved hazardous waste in yellow bag to CBMWTDF for incineration.

Blood bank

The discarded blood bags are to be counted, sealed, weighed and all the records to be made; then packed in autoclave-safe plastic bags or containers to be autoclaved on site which are sent for incineration.

Note: 5% hypochlorite is not effective for high organic loads like blood.

- Pre-treatment for the dental department requires installing amalgam separators in sinks, especially by patient treatment chairs; the separated mercury waste must be safely stored.
- Silver X-ray film developing liquid, after resource recovery, the chemical liquid waste needs to be pre-treated before mixing with waste water.
- Pre-treatment for the radiotherapy department involves separate collection of radioactive wastewater (e.g. urine of patients from the thyroid treatment) and storage for decay in a secured die-away basin until background concentrations have decreased; after the required storage time (Ten half lives), the wastewater can be disposed of in the sewer system

On Site Biomedical Waste Treatment Options

Before we proceed to the Onsite Biomedical Waste Treatment Options let us recapitulate a bit on the background.

BMW management and handling rules in India were formulated in 1998, which were again amended in 2016.

Some Major Differences in the rules of 1998 and 2016

Sl. No	1998	2016
1	Occupiers with more than 1000 patients required to obtain authorisation	Every occupier generating BMW, including health camp or AYUSH requires to obtain authorisation
2	Occupier duties absent	Duties of the operator listed
3	BMW divided into ten categories	Biomedical waste divided into 4 categories
4	Rules restricted to HCEs with more than 1000 beds	Treatment and Disposal of BMW made mandatory for all the HCEs
5	No format for Annual Report	A format for Annual report appended with the rules
6	Schedule I, II , III, IV and V	Change of schedule I, II, III and IV

The current categories of BMW as per BMW management rules of 2016 are as follows:

Category	Type of Bag/Container used	Type of Waste	Treatment/ Disposal Options
Yellow 	Non- chlorinated plastic bags Separate Collection System leading to effluent Treatment System	a) Human Anatomical Waste b) Animal Anatomical Waste c) Soiled Waste d) Expired or Discarded Medicines e) Chemical Waste f) Micro, Bio–technology and other clinical lab waste g) Chemical liquid Waste	Incineration or Plasma Pyrolysis or deep Burial*
Red 	Non- chlorinated plastic bags or containers	**Contaminated waste (Recyclable)** tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles) and gloves.	Auto/Micro/ Hydro and then sent for recycling not be sent to landfill
White 	(Translucent) Puncture, Leak,	**Waste sharps including Metals**	Auto or dry Heat Sterilization followed by

	Tamper proof containers		shredding or mutilation or encapsulation
Blue	Cardboard boxes with blue collared marking	**Glassware**	Disinfection or auto/Micro/hydro and then sent for recycling.

Bar Coded waste bags for BMW handling

Provision of colour coded bags as per BMWR-2016 for storage and transport of biomedical waste. Most institutions have started providing barcode for bags for biomedical waste storage and handling.

Packaging: The containers or bags referred to in sub-rule are labelled as specified in Schedule IV. The Bar code is placed on the packages.

Transportation: Internal transportation is done through Transport trolleys as shown below.

The operator of common bio-medical waste treatment facility transports the bio-medical waste from the premises of the hospital to common bio-medical waste treatment facility. The vehicles are labelled as provided in part 'A' of the Schedule IV along with necessary information as specified in part 'B' of the Schedule IV. The vehicles used for transportation of bio-medical waste shall comply with the conditions if any stipulated by the State Pollution Control Board or Pollution Control Committee in addition to the requirement contained in the Motor Vehicles Act, 1988 (59 of 1988), if any or the rules made there under for transportation of such infectious waste. Dedicated Vehicles are required to be deployed for transportation of Bio-Medical waste from Health Care Establishments to the facility. All the vehicles should be covered and having GPS System.

Various Methods of waste disposal

Often the waste categorised as per various methods of waste disposal is spoken of in the same terms as type of waste which may not be categorically same. But methods of disposal are one of the principal players in the biomedical waste management system

<u>Some important methods of disposal</u> :-

Incineration - Controlled incineration at high temperatures (over 1000°C) is one of the few technologies with which all types of health-care waste can be treated and it has the advantage of significantly reducing the volume and weight of the wastes treated. However, Incinerators require special infrastructure and are suitable for central networks and not the hospitals.

Chemical disinfection: - Chemical disinfection, which is commonly used in health facilities to kill micro-organisms from medical equipment, has been extended to the treatment of health-care wastes. However, the chemicals that are used themselves entail a health risk for the people who handle them and a risk of environmental pollution.

This form of disposal is more suited to disposing infectious fluid waste like body fluids and hospital sewage. Although it has its downside in that certain harmful gases may be released on chemical disinfection of urine with bleach.

Autoclaving: - Autoclaving is a thermal process at low temperatures where waste is subjected to pressurized saturated steam for a sufficient length of time to be disinfected (60 minutes at

121°C and 1 bar). Where prions (which cause Creutzfeldt Jakob's disease) are present, a cycle of 60 minutes at 134°C is recommended, since they are exceptionally resistant. Efficiency tests (biological or thermal) must in any case be carried out regularly. Autoclaving is environmentally safe but in most cases, it requires electricity, which is why in some regions it is not always feasible for treating wastes.

Needle Extraction or Destruction: This practice is followed in certain circumstances, mainly for two reasons: when the needles are removed from used syringes they cannot be re-used, and, secondly, the volume of sharps is reduced.

Microwave treatment technologies

Microwave technology is a steam-based process where the treatment occurs through the action of moist heat and steam generated by microwave energy with a cycle of 30 min to 1 h. The types of waste treated are cultures and stocks, sharps, materials contaminated with blood and body fluids, other infected waste, laboratory waste and soft waste (e.g., gauze, bandages, gowns and bedding). Microwave treatment should not be used for cytotoxic, volatile compounds, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items. Biological indicators for microwave are *Bacillus atrophaeus* spores.

Autoclave and Shredders The autoclavable waste from Hospitals is also autoclaved in GB pant hospital in case LNH Autoclave is out of order but this waste is shredded in LNH itself.

Shredders cut the waste into small pieces. This technique requires competent staff for operating and maintaining the device, since some of these rotary devices are industrial models. They are often built into closed chemical or thermal disinfection systems. However, grain mills can be converted into simple shredders, but due to the risk for staff while the shredder is running only disinfected waste should be treated in these devices

Encapsulation: - Encapsulation (or solidification) consists of containing a small number of hazardous items or materials in a mass of inert material. The purpose of the treatment is to prevent humans and the environment from any risk of contact. Encapsulation involves filling

containers with waste, adding an immobilizing material, and sealing the containers. The process uses either cubic boxes made of high-density polyethylene or metallic drums, which are three-quarters filled with sharps, chemical or pharmaceutical residues, or incinerator ash. The containers or boxes are then filled up with a medium such as plastic foam, bituminous sand, lime, cement mortar, or clay. Once the medium has dried, the containers are sealed and disposed of in a sanitary landfill or waste burial pit[1].

Sanitary landfill or waste disposal pit: - The disposal of untreated health-care waste in an uncontrolled dump is not recommended and must only be used as a last resort. It can be disposed off in a sanitary landfill, subject to certain precautions: it is important that health-care waste be covered rapidly. One technique is to dig a trench down to the level where old municipal refuse (over three months old) has been buried and to immediately bury health-care waste that is discarded at this level under a 2-metre layer of fresh municipal refuse

Disposal of liquid wastes in the sewage: - In general, the sewage system should not be used to dispose of chemicals. It is strictly prohibited to dilute wastewater discharges so that the concentration falls below the exemption thresholds in force in a particular country.

Effluent Treatment Plant: - Facility for effluent treatment has to be provided and to ensure that all streams, sewage, sullage (floor wash, hand wash, bathroom wash and canteen effluent & laundry and disinfected biomedical liquid effluent) are connected to ETP. 80 % of the water consumption is considered as Effluent generation. Ensure adequate capacity for ETP and Water meters should be installed to record water consumption and monthly water consumption reports has to be submitted. Operation and maintenance of ETP is to be carried out at regular intervals. Effluent monitoring reports as per the periodicity specified and proper disposal of treated effluent as specified is to be carried out.

The waste treatment technologies in Developed countries include thermal, chemical processes, irradiation technologies, biological processes, disinfection and sterilisation.

Thermal: Autoclaves: Steam treatment technologies

Autoclaves sterilise a range of infectious waste (cultures, stocks, sharps, materials

contaminated with blood and fluids), laboratory waste, linen waste and medical instruments and as a part of pre-treatment of BMW. Unlike instrument-sterilisation autoclaves, waste-treatment autoclaves (or pre-vaccum autoclaves) must also treat the air that is removed at the start of the process to prevent the release of pathogenic aerosols through a high-efficiency particulate air filter before it is released and therefore require less time for action and have greater efficiency.

The autoclaves should be able to withstand the repeated build-up and release of steam pressures and should have construction materials, engineering design, fabrication, accuracy of pressure and temperature sensors, and testing must meet basic requirements to operate safely as per the international standards. The operation of autoclave requires a minimum of recommended temperature–exposure time criterion of 121°C for 30 min, pressure of 205 kPa or 2.05 bar

Unlike Autoclaves for medical devices which often use trays or stainless steel baskets, Waste autoclaves use autoclavable carts or bucket-shaped open containers into which the plastic waste bags are stacked. For the same, use of autoclavable plastic bags or liners that prevent sticking is an option.

A post-treatment shredder or grinder could be used if the waste is to be rendered unrecognisable and if reduction of waste volume is desired. Advanced single- or multiple-shaft shredders specially made for medical waste can reduce waste volume by about 80%. The advanced shredders are typically low-speed, high-torque, single-pass shredders with easily replaceable cutters and with discharge screens to control the size of shredded waste.

Dry heat treatment technologies

Hot air ovens have been used to sterilise glassware and other reusable instruments and infectious health waste. The waste is heated by conduction, natural or forced convection or thermal radiation at higher temperatures (up to 185°C) and longer exposure times (90–150 min)

than steam-based processes. It should completely and consistently kill the biological indicator Geobacillus stearothermophilus.

Chemical disinfectants: The disinfectants used are chlorine compounds, aldehydes, lime-based powders or solutions, ozone gas, ammonium salts and phenolic compounds.

Sodium hypochlorite (NaOCl, 2%–12%), (BMW Rules 2016 say 10%) it is active against bacteria, viruses and spores, not effective for disinfection of liquids with high organic content, (blood or stool) and is widely used owing to relatively mild health hazards. Unused solutions should be reduced with sodium bisulphite or sodium thiosulphate and neutralised with acids before discharge into sewers. PPEs should be worn to protect HCWs. Chlorine dioxide is an alternative to hypochlorite. It is a toxic but soluble and stable in water and can be generated onsite. Lime-based chemical treatment systems use dry powder or calcium hydroxide solutions. Glutaraldehyde and peracetic acid are used to disinfect instruments.

Other Emerging technologies

Emerging technologies include plasma pyrolysis, alkaline hydrolysis, superheated steam, ozone and promession.

Other emerging technologies for destruction of BMW include gas-phase chemical reduction, base-catalysed decomposition, supercritical water oxidation, sodium reduction, verification, superheated steam reforming, Fe-TAML/peroxide treatment (pharmaceutical waste), biodegradation (using mealworm or bacteria to eat plastics), mechanochemical treatment, sonic technology, electrochemical technologies, solvated electron technology and phytotechnology. These emerging technologies are not ready for routine application to health-care waste

Promession

Promession is an innovative method of ecological burial. Its primary principles are preservation after death in organic form, and shallow burial in living soil that quickly converts a body to a form that is primed to foster new life. Promession is a natural, practical, and some may even say a beautiful approach because of its focused intent to foster new life from death.

Susanne Wiigh-Masak, a Swedish biologist, spent over 20 years on the concept before making it public. She wondered how it would be possible to use human remains to create soil that was

primed to nurture new life, essentially, creating life out of death. While this concept can be observed in nature on a continual basis, it is a concept that may seem foreign and perhaps a bit uncomfortable when applied to the death of a human.

The process is described by Susanne as gentle and environmentally-friendly, especially in comparison to the process of cremation (which requires fire, fumes, etc.). The result is a product that is transformed into an organic, hygienic soil in about 6-12 months that can then act as a nutrient for new plants as a living memorial for family and friends.

The process of promession is simple and straightforward:

- The body is frozen to -18 ° C and is then placed into liquid nitrogen to make the body more brittle.
- The body is then vibrated, which causes it to break down into an organic powder.
- The body is then placed into a vacuum chamber to evaporate all liquid.
- The resulting dry powder passes through a metal separator where any metals and mercury are removed.
- The remains are now ready to be laid in a biodegradable coffin, which is buried in the living topsoil.
- The coffin and its contents become compost in about 6-12 months.
- A bush or tree can be planted above the coffin.
- The compost can be taken up by the bush or tree,
- The plant stands as a symbol of the deceased.

OFF SITE WASTE MANAGEMENT OPTIONS

A Common Bio-medical Waste Treatment and Disposal Facility (CBWTF) is a set up where biomedical waste generated from member health care facilities is imparted necessary treatment to reduce adverse effects that this waste may pose on human health and environment. The treated recyclable waste may finally be sent for disposal in a secured landfill or for recycling. According to the Bio-medical Waste Management Rules, 2016, "bio-medical waste treatment and disposal facility" means any facility wherein treatment, disposal of bio-medical waste or processes incidental to such treatment and disposal is carried out, and includes common bio-medical waste treatment facilities and "operator of a common bio-medical waste treatment facility" means a person who owns or controls a Common Bio-medical Waste Treatment and

Disposal Facility (CBWTF) for the collection, reception, storage, transport, treatment, disposal or any other form of handling of bio-medical waste. By running the treatment equipment at CBWTF to its full capacity, the cost of treatment of per kilogram bio-medical waste gets significantly reduced. Its considerable advantages have made CBWTF popular and proven concept in most part of the world. Since 1998, the CBWTF as an option for treatment of bio-medical waste also been legally introduced in India. Now the Bio-medical Waste Management Rules, 2016 restricts the Occupier (i.e., HCF) for ensuring treatment and disposal of generated bio-medical waste through a CBWTF, located within a distance of 75 KM. To facilitate the treatment and disposal of bio-medical waste generated from the HCFs, at present (as per Annual Report 2014 submitted by the SPCBs/PCCs), there are 192 no. of CBWTFs in operation and 33 no. of CBWTFs are under construction. Also, the Bio-medical Waste Management Rules, 2016 mandates that the operator of a CBWTF authorised by the prescribed authority is required to take all necessary steps to ensure that the bio-medical waste collected from the occupier is transported, handled, stored, treated and disposed of, without any adverse effect to the human health and the environment, in accordance with the BMWM Rules and the guidelines issued by the Central Government or the Central Pollution Control Board (CPCB) from time to time.

Criteria for development of a new Common Bio-medical Waste Treatment and Disposal Facility for a locality or region. Prior to allowing any new CBWTF, following criteria or steps may be followed:

a) Prescribed authority under the BMWM Rules, 2016 [i.e., State Pollution Control Board (SPCB)/committee is required to prepare an inventory or review with regard to the bio-medical waste generation at least once in five years in the coverage areas of the existing bio-medical waste treatment and disposal facility.
b) SPCB/PCC is required to conduct gap analysis w.r.to coverage area of the bio-medical waste generation and also projected over a period of next ten years, adequacy of existing treatment capacity of the CBWTF in each coverage area of radius 75 KM,
c) SPCB/PCC shall identify the coverage area, which require additional treatment facility and bring it to the notice of the concerned department in the business allocation of land assignment in the respective State Government or UT Administration.
d) Alternately, a CBWTF may also be allowed to be established on a land procured by an entrepreneur in accordance with the location criteria suggested under these guidelines.

e) The SPCB/PCC or concerned department in the business allocation of land assignment in the respective State Government or UT Administration may seek expression of interest from the proponents for development of new CBWTF (s) in the identified coverage area.
f) In the absence of expression of interest by any proponent, then SPCB/PCC shall insist health care facilities to form association and to develop its own CBWTF in line with these guidelines
g) In case of any regulatory action including closure of any existing CBWTF is inevitable, the respective SPCB/PCC may take action under the BMWM Rules including for making alternate arrangement to ensure safe disposal of the bio-medical waste generated from the member health care facilities of such default CBWTF through CBWTF located nearby.
h) In case of hilly areas considering the geography, only one CBWTF with adequate treatment capacity may be developed covering at least two districts to cater treatment services to the HCFs located in the respective Districts.

Duties of the operator of a common bio-medical waste treatment and disposal facility. Also, all the existing CBWTFs shall also complete augmentation of the existing incineration facility so as to comply w.r.to the residence time as well as emission norms including for Dioxins and Furans prescribed under BMWM Rules, 2016 within two years from the date of notification of the BMWM Rules, 2016 (i.e., prior to 27.03.2018). In addition to the above, to ensure proper management of bio-medical waste in the respective coverage area, as a mitigation measure, especially in the event of (a) a temporary break down (not more than a week) of a CBWTF especially for rectification of the refractory lining of the incineration chambers or change of requisite APCD due to failure

The action plan should also include:

a) A MoU made with the nearest CBWTF located within the respective State/UT, as alternate arrangement. In case, if there is no CBWTF located nearby then such CBWTF should have to install stand by treatment equipment (equal to the existing treatment capacity as per consents granted by the SPCB/PCC), and
b) Decontamination plan of the CBWTF for execution of such plan prior to closure of a CBWTF.

Applicability of these Guidelines: These guidelines are applicable to all the upcoming or new CBWTFs. In case of the existing CBWTFs, these guidelines shall be applicable in case

a) the existing CBWTFs desires to expand or enhance the existing treatment capacity (or)
b) the existing CBWTFs desires to modernize the existing treatment equipment with the new equipment with enhancement in the existing treatment capacity. Revised Guidelines for Common Bio-medical Waste Treatment Facilities 7

Environmental laws applicable for commissioning or operation of a CBWTF Operation of a CBWTF lead to air emissions as well as waste water generation as in case of an industrial operation. Most common sources of waste water generation in CBWTFs are vehicle washing, floor washing, and scrubbed liquid effluent from air pollution control systems attached with the incinerator/plasma pyrolysis. Incineration as well as DG Set is the general source of air emissions.

Consents under Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981 as well as Authorization under the BMWM Rules, 2016 The project proponent of the CBWTF is required to obtain 'Consent to Establishment' under Rule 25 of the Water (Prevention and Control of Pollution) Act, 1974 and under Rule 21 of the Air (Prevention and Control of Pollution) Act, 1981, from the respective prescribed authority i.e. SPCB/PCC.

Environmental Clearance under EIA Notification 2006 Ministry of Environment, Forest & Climate Change (MoEF & CC), notified amendment to the EIA Notification 2006 and published vide MoEF & CC Notification of S.O. 1142 (E) dated April 17, 2015. According to this notification, the 'bio-medical waste treatment facility' is categorized under the Item 7 (da) in the schedule, requiring 'environmental clearance' from the State Environment Impact Assessment Authority (SEIAA).

Location criteria: In the context of these guidelines, buffer zone represents a separation distance between the source of pollution in CBWTF and the receptor - following the principle that the degree of impact reduces with increased distance.

The location criteria for development of a CBWTF are as follows:

a. A CBWTF shall preferably be developed in a notified industrial area without any requirement of buffer zone (or)
b. A CBWTF can be located at a place reasonably far away from notified residential and sensitive areas and should have a buffer distance of preferably 500 m so that it shall Revised Guidelines for Common Bio-medical Waste Treatment Facilities 9 have minimal impact on these areas. In case of non-availability of such a land, the buffer

zone distance from the notified residential area may be reduced to less than 500 m by SPCB/PCC without referring the matter to

c. The CBWTF can also be developed as an integral part of the Hazardous Waste Treatment Storage and Disposal Facility (TSDF) subject to obtaining of necessary approvals from the authorities concerned including 'environmental clearance' as per Environmental Impact Assessment 2006 and further amendments notified under the Environment (Protection) Act, 1986, provided there is no CBWTF exist within 150 KM distance from the existing TSDF.

Land requirement: Sufficient land shall be allocated to the CBWTF to provide all requisite systems which include dedicated space for storage of waste (both treated and untreated), waste treatment equipment, vehicle washing bay, vehicle parking space, ETP, incineration ash storage provision, administrative room, space for DG Set etc.,.

Coverage area of CBWTF Suggested coverage area for development of a CBWTF is as follows:

A CBWTF located within the respective State/UT shall be allowed to cater healthcare units situated at a radial distance of 75 KM. However, in a coverage area where 10,000 beds are not available within a radial distance of 75 KM, existing CBWTF in the locality (located within the respective State/UT) may be allowed to cater the healthcare units situated upto 150 KM radius w.r.to its location provided the bio-medical waste generated is collected, treated and disposed of within 48 hours as stipulated under the BMWM Rules.

In case of hilly areas, considering the geography, only one CBWTF with adequate treatment capacity may be developed covering at least two districts to cater treatment services to the HCFs located in the respective Districts.

Treatment equipment: The Common Bio-medical Waste Treatment Facility should treat the bio-medical waste as per BMWM Rules and as per the authorisation granted by the prescribed authority.

The CBWTF should have the following treatment facilities:

a) Incineration/Plasma Pyrolysis Incineration is a controlled combustion process where waste is completely oxidized and harmful microorganisms present in it are destroyed/ denatured under high temperature. The guidelines for "Design & Construction Requirements of Bio-medical Waste Incinerators" by CPCB from time to time shall be

followed for selecting/or augmenting the incinerator. Revised Guidelines for Common Bio-medical Waste Treatment Facilities

Plasma Pyrolysis is an alternate to incinerator, Plasma Pyrolysis treatment technology can be installed for disposal of bio-medical waste categories as per BMWM Rules wherein destruction of bio-medical waste is similar to incineration can be achieved. In case of plasma pyrolysis, waste is treated at high temperature under controlled condition to form gases like methane, hydrogen and carbon monoxide which are subjected to combustion (oxidation) in secondary chamber. In the plasma pyrolysis process waste is converted into small clinker which can be disposed in secured landfills.

b) Autoclaving/Hydroclaving (i) Autoclaving is a low-heat thermal process where steam is brought into direct contact with waste in a controlled manner and for sufficient duration to disinfect the wastes as stipulated under the Bio-medical Waste Management Rules. For ease and safety in operation, the system should be horizontal type and exclusively designed for treatment of bio-medical waste. For optimum results, pre-vacuum based system be preferred against the gravity type system. It shall have tamper-proof control panel with efficient display and recording devices for recording critical parameters such as time, temperature, pressure, date and batch number etc. as required under the BMWM Rules. (ii) Hydroclaving is similar to that of autoclaving except that the waste is subjected to indirect heating by applying steam in the outer jacket. The waste is continuously tumbled in the chamber during the process.

c) **Microwaving:** In microwaving, microbial inactivation occurs as a result of the thermal effect of electromagnetic radiation spectrum lying between the frequencies 300 and 300,000MHz. Microwave heating is an inter-molecular heating process. The heating occurs inside the waste material in the presence of steam.

d) **Chemical disinfection**: Though chemical disinfection or alternates as stipulated under the BMWM Rules is also an option for treatment of certain categories of biomedical waste such as glass waste but looking at the volume of waste to be disinfected at the CBWTF and the

pollution load associated with the use of chemical disinfectants, the chemical disinfection for treatment of bio-medical waste as part of a CBWTF may be used sparingly or avoided as far as possible.

e) **Dry heat sterilization**: This is the additional option for treatment of waste sharps as stipulated under the BMWM Rules. In this method, waste sharps are treated using Revised Guidelines for Common Bio-medical Waste Treatment Facilities 12 dry heat (hot air) at a temperature not less than 1850 C, at least for a residence period of 150 minutes in each cycle (with sterilization period of 90 minutes).

f) Shredder: Shredding is a process by which waste are de-shaped or cut into smaller pieces so as to make the wastes unrecognizable. It helps in prevention of reuse of bio-medical waste and also acts as identifier that the wastes have been disinfected and are safe to dispose off. A shredder to be used for shredding bio-medical waste shall confirm to the following **minimum requirements**:

(i) The shredder for bio-medical waste shall be of robust design with minimum maintenance requirement;

(ii) The shredder should be properly designed and covered to avoid spillage and dust generation. It should be designed such that it has minimum manual handling;

(iii) The hopper and cutting chamber of the shredder should be so designed to accommodate the waste bag full of bio-medical waste;

(iv) The shredder blade should be highly resistant and should be able to shred waste sharps, syringes, scalpels, blades, plastics, catheters, intravenous sets/ bottles, blood bags, gloves, bandages etc. It should be able to handle/ shred wet waste, especially after microwave/ autoclave/hydroclave;

(v) The shredder blade shall be of non-corrosive and hardened steel;

(vi) The shredder should be so designed and mounted so as not to generate dust, high noise & vibration;

(vii) If hopper lid or door of collection box is opened, the shredder should stop automatically for safety of operator;

(xiv) The minimum capacity of the motor attached with the shredder shall be 3 KW for 50 Kg/hr, 5 KW for 100 kg/hr & 7.5 KW for 200 Kg/hr and shall be three phase induction motor. This will ensure efficient cutting of the bio-medical wastes as prescribed in the Bio-medical Waste Management Rules; and

Sharp pit/ Encapsulation: A sharp pit or a facility for sharp encapsulation in a metal container or cement concrete shall be provided for treated sharps (i.e., treatment by autoclaving or dry heat sterilization followed by shredding or mutilation).

Deep burial: Any SPCB/PCC should not allow the 'deep burial' of bio-medical waste as a part of CBWTF. Any existing CBWTF having disposal of bio-medical waste by deep burial should have the requisite treatment equipment as stipulated under the BMWM Rules, within six months from the date of finalization of these guidelines.

Vehicle/Containers washing facility: Every time a vehicle is unloaded, the vehicle and empty waste containers shall be washed properly and disinfected. Washing can be carried out in an open area but on an impermeable surface and liquid effluent so generated shall be conveyed and treated in an effluent treatment plant. The impermeable area shall be of appropriate size so as to avoid spillage of liquid during washing.

Effluent Treatment Plant: A suitable Effluent Treatment Plant (ETP) shall be installed to ensure that liquid effluent generated during the process of washing containers, vehicles, floors etc. is treated and reused after treatment.

ETP may also have the following provisions:

(i) separate 'energy meter' pH meter and A 'magnetic flow meter' should also be fitted so as to know total consumption of electricity for operation of the machinery attached with the ETP.

Infrastructure set up the CBWTF A CBWTF shall have the following infrastructure: a) Treatment Equipment Room A separate housing may be provided for each treatment equipment at the CBWTF such as incinerator room, autoclave room, microwave room etc., as applicable. Each room shall have well-designed roof and walls. Such room shall be well ventilated and easy to wash. The floor and interior finishing of the room shall be such that chances of sticking/harbouring of microorganisms are minimized. This can be attained by Note:

b) **All the treatment equipment** should be operated and complied with the norms as stipulated under Schedule II of the Bio-medical Waste Management Rules, 2016 published by MoEF & CC vide GSR 343 (E) dated 28th March, 2016.

c) Incinerator / Plasma Pyrolyisis/ Autoclaving/Microwaving/ Hydroclaving/ Shredder/ Dry Heat Sterilization/ ETP should be fitted with separate 'energy meter' for recording total energy consumed for operation of these equipment. all the CBWTF operators should also be provided with stand by treatment equipment especially incinerator/plasma pyrolysis/autoclave (or) alternately MoU made with the nearby CBWTF (located within the State/UT) shall be submitted to the respective SPCB/PCC,

Mercury storage The capacity of the mercury storage provision should be maximum of 90 days and by which the collected mercury bearing waste shall have to be disposed of through a TSDF located nearby following the manifest as per Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016.

d) **Administrative Room** This room shall be utilized for general administration, record keeping, billing etc.

e) **Generator set CBWTF** shall have a generator set of adequate capacity as standby arrangement for power, with sufficient capacity to run the treatment equipment during the failure of power supply. The generator set shall comply with the necessary requirement as per DG Set norms notified under the Environment (Protection) Act, 1986.

f) **Continuous emission monitoring system** (CEMS) Monitoring provision for continuous monitoring of the incinerator/plasma pyrolysis stack emission shall be installed by the CBWTF operators for the parameters as stipulated by the respective SPCB/PCC as per the authorisation granted under the BMWM Rules, 2016.

g) **Vehicle Parking** Provision for parking shall be made within the confines of the site for parking of required number of vehicles, loading and unloading of the vehicles meant for transporting waste to and from the facility, etc. In case of a CBWTF with space constraints, multy-storey parking or a separate provision may be allowed only for parking of vehicles.

h) **Display and sign board** An identification board (Display) of durable material and finish shall be displayed at the entrance to the facility. This shall clearly display the name of the facility, owner name, address and telephone number of the operator and the prescribed authority, no. of hours of operation & operational hours, telephone numbers of the personnel to be contacted in the event of an emergency, validity period of authorization as well as total daily waste treated and disposed. Also, sign boards should be provided at all the salient points (untreated waste storage area, treatment equipment, treated waste storage area, ETP, firefighting equipment) within the facility.

i) **Washing Room** A washing room shall be provided for eye washing/hand washing/ bathing etc. for the workers.

j) **Site Security** High walls, fencing and guarded gates shall be provided at the facility to prevent unauthorized access to the site by humans and livestock.

k) **Fire safety** Fire safety equipment such as sand buckets and fire extinguishers should be provided at all the salient points of the CBWTF including at the diesel storage areas, diesel tanks connected with the incinerator etc. Fire alarm also should be provided within the CBWTF

to prompt the workers in the event of any fire hazard. Workers should also be trained in First Aid administration.

l) **First Aid Box** First Aid Box with necessary provisions need to be provided at all the salient points within the facility.

m) **Green Belt** The open area available within the CBWTF shall be developed into green belt.

n) **Website:** (newly added as per BMWM Rules, 2016) All the existing CBWTFs shall develop own website by 27.03.2017 whereas the upcoming CBWTF shall develop the website prior to the commencement of the facility. The website should be uploaded with relevant information periodically (on monthly basis) especially as detailed below:

(i) A copy of the Environmental Clearance obtained;

(ii) **Copies of the Consents** under the Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981 as well as the Authorisation under the BMWM Rules obtained from the SPCB/PCC;

(ii) List of all the member Health Care Facilities with complete address, bedded or non-bedded HCFs, no. of beds, bar code, category-wise average bio-medical waste generation in kg/annum;

(iv) Charges levied on the member Health Care Facilities (HCFs) for treatment and disposal of bio-medical waste;

(v) Vehicles connected with a provision of GPS as per BMWM Rules and Vehicle-wise route chart for collection, transportation of bio-medical waste from the member HCFs;

(vi) Real time continuous online stack emission monitoring data;

(vii) Daily bio-medical waste collected, received and treated (Member HCF-wise);

(viii) Monthly details of total waste collected from the member HCFs, total waste treated, and treated recyclable plastic waste or glass waste sold to the parties and final mode of disposal of incineration ash;

(ix) A copy of the annual report submitted to the respective SPCB/PCC;

(x) Monitoring results of the stack emissions, treated wastewater and incineration ash, as per the frequency stipulated under the BMWM Rules;

(xi) List of HCFs (located within the coverage area) with complete address which have not taken membership of the CBWTF for disposal of Bio-medical waste;

- Contact person, contact telephone number and e-mail addresses of the facility; and. Revised Guidelines for Common Bio-medical Waste Treatment Facilities 20

- (xiii) Provision to have access to the SPCB/PCC/CPCB/MoEF & CC/MoH & FW especially on GPS, online monitoring system and the data. Besides the provisions suggested in the earlier paras,

Following important provisions should also be made in a CBWTF:

(i) A telephone shall be provided and maintained at the facility.

(ii) A First Aid Box shall be provided and maintained at the CBWTDF.

(iii) Proper lighting shall be provided at the facility.

(iv)Proper care shall be taken to keep the facility and surroundings free from odors.

(v) Measures shall be implemented to control pests and insects at the site.

(vi)Measures shall be implemented to control the escape of litter from the site.

(vii) Necessary provision shall be made to prevent and control noise generated, if any, due to the activities at the site.

(viii) Necessary protective gear for the waste handlers shall be provided.

(ix) Immunization to all the workers of CBWTF against all the diseases including especially Tetanus and Hepatitis -B as stipulated under the BMWM Rules.

(x) Workers should have provisions such as washing, toilet, and suitable place for eating.

(xi) Workers should also be provided with N-95 mask besides other PPEs such as hand gloves, gumboots, goggles etc. Every CBWTF operator shall submit a work-plan to the Prescribed Authority.

11) Record keeping: Maintenance of records for all operations carried out at the CBWTF is very important to monitor overall operation of the CBWTF. It also helps in submission of the required information to be submitted to the 'Prescribed Authority' by 30 th June of every year as per the format prescribed under the BMWM Rules or provided by the SPCB/PCC. A well-maintained record of all the activities at the CBWTF also enables the facility operator to produce all information of the activities on demand of the concerned prescribed authority. The record should include all information relating to each activity at the CBWTF site as per BMWM Rules which include accidents occurred (spills, injury, fire accident) and the measures taken and also, however, minimum requirement is outlined below:

Records of waste movements Daily records shall be maintained for the waste accepted and treated waste removed from the site. This record shall include the following minimum details:

(i) Waste accepted: -Records on day-to-day basis (as per the format given at Annexure-II) shall be maintained with respect to the waste collection date, name of the healthcare unit with bar code, waste category as per BMWM Rules, category-wise quantity of waste

accepted, vehicle registration number used for collection of bio-medical waste from member health care facilities, time at which waste collected from member HCFs, name of the vehicle driver and his signature and waste receiving date & time (at CBWTF site). Similar information to be acknowledged to the member health care facility by the CBWTF operator on daily basis.

(ii) Treated waste to be disposed:- Date, treated waste type, Quantity, vehicle number, disposal as stipulated under BMWM Rules.

b) **Logbook for the treatment equipment** A logbook shall be maintained for each treatment equipment installed at the site and shall include the following:

(i) The weight of each batch.

(ii) The categories of waste as per the Rules.

(iii) The time, date and duration of each treatment cycle and total hours of operations.

(iv) The complete details of all operational parameters during each cycle. Log book to be maintained for operating the incinerator/plasma pyrolysis as well as the autoclave as per the formats given at Annexure –III.

c) **Monitoring and reporting of operations in the CBWTF:** The monitoring of the key operating parameters of treatment equipment provides several benefits. First, monitoring provides the operator with information needed to make decisions on necessary combustion control adjustments. Second, properly maintained monitoring records can provide useful information for identifying operating trends and potential maintenance problems. Following are the suggested parameters for monitoring of the treatment equipment

(i) Monitoring of operating parameters of the incinerator/plasma pyrolysis: Following operating parameters can be monitored in case of incinerator/plasma pyrolysis: ¬ Waste charge rate. ¬ Combustion gas temperature in primary and secondary chamber as well as the temperature of the stack exit gas (flue gas). ¬ Condition of the draft (negative draft in primary chamber). ¬ Combustion gas oxygen level in primary and secondary chamber as well as stack exit gas. ¬ Air flow rate through the incinerator/plasma pyrolysis. ¬ Carbon-Di-Oxide (CO2), Oxygen (O2) and Carbon Monoxide (CO) level in the flue gas. ¬ Quantity of auxiliary fuel usage as well as the power consumption (in every batch). ¬ Pressure drop in the primary chamber and APCD attached with the incinerator/plasma pyrolysis and ¬ Bottom ash or slag quality (for Total Organic Carbon (TOC) as well as loss on ignition and the hazardous constituents (at least once in a quarter).

(ii) Monitoring of operating parameters of the Autoclave: Following operating parameters can be monitored during the sterilization using autoclave: ¬ Time at which sterilization started and time at which sterilization completed. ¬ Temperature conditions maintained throughout the sterilization ¬ Conditions of pressure maintained throughout the sterilization ¬ Duration of sterilization ¬ Validation test results Records concerning the above parameters need to be maintained and checked periodically for taking remedial measures during the operation of the incinerator or plasma pyrolysis or autoclave. In case of other treatment processes, the operational conditions as well as the efficacy tests to be complied with as per the standards prescribed under the BMWM Rules.

Frequency of monitoring: The CBWTF operator shall carry out following tests through a NABL approved laboratory or a laboratory approved under the Environment (Protection) Act, 1986,

- Suggested validation test for treatment of bio-medical waste by autoclave/microwave/chemical treatment/Dry heat sterilization S. No Type of equipment used for treatment of bio-medical waste Type of Validation Test Frequency (i) Autoclave (i) biological indicator strips or vials Geobacillus stearothermophilus spores with at least 1X106 spores), once in three months (ii) chemical indicator strip or tape each batch of waste treated (ii) Microwave Bacillus atrophaeus spores using vials or spore strips with at least 1 x 104 spores per detachable strip Recommended: once in three months (iii) Chemical treatment followed by shredding Bacillus Subtilis (ATCC 19659)- 4 Log10 reduction or greater Once in a week (iv) Dry heat sterilisation consistently kill the biological indicator Geobacillus Stearothermophillus or Bacillus Atropheaus spores using vials with at least 6 log10 spores per ml. Once in three months A chemical indicator strip or tape Once in a week d) Site Records:

Site records shall include the following:

(i) All the approvals obtained from other concerned departments other than the prescribed authority;

(ii) Details of construction or engineering works;

(iii) Maintenance schedule, breakdowns/trouble shootings and remedial actions;

(iv) Emergencies;

(v) Incidents of unacceptable waste received and the action taken; and

(vi) Details of site inspections by the officials of the regulatory authorities, purpose of visits with date and necessary actions initiated on the observations. Revised Guidelines for

Common Bio-medical Waste Treatment Facilities 25 Daily, monthly and annual summary records of all the above shall be maintained and made available at the site for inspection and same submitted whenever required by an authorized official of the concerned regulatory authorities.

12) Collection and transportation of bio-medical waste The collection and transportation of bio-medical waste shall be carried out in a manner so as to prevent any possible hazard to human health and environment. Collection and transportation are the two operations where the chances of segregated bio-medical waste coming in contact with the public, rag pickers, animals/birds, etc. are high. Therefore, all care shall be taken to ensure that the segregated bio-medical waste handed over by the healthcare units reach CBWTF without any damage, spillage or unauthorized access by public, animals etc. A responsible person from the CBWTF operator shall always accompany the vehicle to supervise the collection and transportation of bio-medical waste. Also, the private transport vehicles should not be authorised by the SPCBs/PCCs only for transportation of the Bio-medical Waste. The CBWTF operator should be made responsible for collection and transportation of bio-medical waste.

a) Collection of bio-medical waste: Generator of the bio-medical waste is responsible for providing segregated waste in accordance with the provisions of the Bio-medical Waste Management Rules, 2016, to the CBWTF operator. Dedicated temporary storage at healthcare unit shall be designated. The coloured bags handed over by the healthcare units shall be collected in similar coloured containers with proper cover. Each bag shall be labelled as per Schedule IV of the Bio-medical Waste Management Rules as well as with bar coding system (to be complied by the occupier or operator of a CBWTF as per BMWM Rules) so that at any time, the healthcare units can be traced back that are not segregating the bio-medical wastes as per BMWM Rules. The coloured containers should be strong enough to withstand any possible damage that may occur during loading, transportation or unloading of such containers. These containers shall also be labelled as per Schedule IV of the Rules. Sharps shall be collected in puncture resistant container. The person responsible for collection of bio-medical wastes shall also carry a register with him to maintain the records such as name of the healthcare unit, the type and quantity of waste received, time at which waste collected from the member HCF, signature of the authorised person from the healthcare unit etc. During transportation, the containers should be covered in order to prevent exposure of public to odours and contamination.

(b) Transportation of the collected bio-medical waste to the CBWTF: CBWTF operator shall not sublet the vehicles used or contract vehicles should not be used by the CBWTF

operator. All the vehicles owned by the CBWTF operator and intended only for collection of bio-medical waste from the member health care facilities should be registered under the Motor Vehicle Act with the respective RTO/Transport Department and such vehicle numbers should also be registered with the respective SPCB/PCC for the purpose of collection of bio-medical waste from the member health care facilities. The bio-medical waste collected in designated coloured containers shall be transported to the CBWTF in a fully covered vehicle. Such vehicle shall be dedicated for transportation of bio-medical waste only. Depending upon the volume of the wastes to be transported, the vehicle may be a two or three-wheeler, light motor vehicle or heavy duty vehicle.

In either case, the vehicle must possess the following:

(i) Transportation vehicle shall be fitted with GPS to track the movement of the vehicle.

(ii) Separate cabins shall be provided for driver/staff as well as for placing the designated colour coded bio-medical waste containers.

(iii) Two wheeler registered under the Motor Vehicle Act shall be permitted for collection of bio-medical waste only from the clinics or dispensaries located in places where the lanes are narrow and not easily accessible to four wheeler vehicles. Such two wheeler vehicle (s) should have a provision of a suitable fixed waste collection box marked with bio-hazard symbol, contact details, proper lid, emergency spill collection procedure, first aid box and manifest record in accordance with the BMWM Rules

(iv) The base of the waste cabin shall be leak proof to avoid pilferage of liquid during transportation.

(v) The waste cabin may be designed for storing waste containers in tiers and also should be provided with a lighting provision.

(vi) The waste cabin shall be so designed that it is easy to wash and disinfect.

(vii) The inner surface of the waste cabin shall be made of smooth surface to minimize water retention.

(viii) The waste cabin shall have provisions for sufficient openings in the rear and/or sides so that waste containers can be easily loaded and unloaded.

(ix) The vehicle shall be labelled with the bio-hazard symbol (as per Schedule IV of the BMWM Rules) and should display the name, address and contact telephone and mobile number of the CBWTF.

(x) The vehicle driver should carry always valid registration of the vehicle obtained from the concerned transport authority and also carry valid ‘pollution under control certificate’ issued by the authorized certificate issuing agency.

Depending upon the area to be covered under the CBWTF, the route of transportation shall be worked out. The transportation routes of the vehicle shall be designed for optimum travel distance and to cover all member healthcare units of the CBWTF. The CBWTF operator should ensure online and real time tracking & monitoring provisions (GPS provision) should be given access with passwords to the SPCB/PCC and CPCB to cross check the movement of the transportation vehicles on any time by the SPCB/PCC/CPCB. As far as possible, the transportation shall be carried out during non-peak traffic hours. If the area to be covered is very large, a satellite station may be established to store the bio-medical waste collected from the adjoining areas. The wastes so stored at satellite station may then be transported to the CBWTF in a big vehicle. It shall be ensured that the total time taken from generation of bio-medical waste to its treatment, which also includes collection and transportation time, shall not exceed 48 hours.

Disposal option of solid waste generated from the CBWTF Treated plastic waste, incineration ash, treated waste sharps and glass waste, Oil & Grease waste and ETP sludge are generally generated from the CBWTF from the treatment systems such as autoclaving/microwaving, incineration, chemical disinfection and effluent treatment plant respectively. The treated bio-medical waste shall be disposed as per the options suggested in the Table 2 given below: Suggested Disposal option of solid waste generated from the CBWTF Sl. No. Treated Waste Category Suggested Treatment and Disposal Options

1. **Plastic wastes** after disinfection and shredding Plastic waste should not be sent to landfill sites. Treated plastic waste to be

(vii) sent to registered or authorized recyclers (or)

(viii) for energy recovery (or)

(ix) for diesel or fuel oil recovery (or) (iv) for road making, whichever is possible.

2. **Disinfected Sharps** (including needles and syringes) (i.e., Treatment by Autoclaving or Dry Heat Sterilization followed by shredding or mutilation combination of shredding cum autoclaving) Encapsulation in metal container or cements concrete; (or) sent for final disposal to iron foundries (having consent to operate from the SPCBs/PCCs (or) sanitary landfill or designated concrete waste sharp pit.
3. **Incineration ash** Incineration ash (ash from incineration of any bio-medical waste) shall be disposed through hazardous waste treatment, storage and disposal facility (TSDF), if toxic or hazardous constituents are present beyond the prescribed limits as given in

Schedule –II of the Hazardous and Other Waste Management & Transboundary Movement Rules or as revised from time to time.

4. **Other treated solid wastes** like Glass waste Disinfection (by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment) or through autoclaving or microwaving or hydroplaning and then sent for recycling.
5. **Oil & Grease** By Incineration
6. **ETP Sludge** After drying in sludge drying beds or removal of moisture content using 'Filter Press' and such ETP sludge shall be given to CBWTF for incineration or to the hazardous waste treatment, storage and disposal facility (HWTSDF) for disposal in Secured Landfill
7. **Hazardous Waste** Disposal through a TSDF located nearby following the manifest as per the Hazardous and Other Waste (Management & Transboundary Movement) Rules, 2016

Cost to be charged by the CBWTF Operator for the Health Care Facilities Cost to be charged from the healthcare facilities plays an important role in financial viability and sustainable operation of a CBWTF project.

Check list for development of CBWTF The criteria for development of CBWTDF have been discussed in detail in the Note: (i) Rates are required to be revised once in a year based on the Wholesale Price Index (WPI Index) or Consumer Price Index (CPI Index

Periodic inspection/monitoring or performance evaluation of the CBWTF To have uniformity in performance evaluation of the CBWTF throughout the country, a check list for performance evaluation of the CBWTF for carrying out inspection/monitoring/compliance verification has been prepared and is annexed (Annexure –V).

Disposal in a sanitary landfill or waste burial pit:-

The disposal of untreated health-care waste in an uncontrolled dump is not recommended and must only be used as a last resort. It can be disposed of in a sanitary landfill, subject to certain precautions: it is important that health-care waste be covered rapidly. One technique is to dig a trench down to the level where old municipal refuse (over three months old) has been buried and to immediately bury health-care waste that is discarded at this level under a 2-metre layer of fresh municipal refuse.

The following are the essential factors that must be taken into consideration in the design and use of a sanitary landfill:

- access must be restricted and controlled;
- competent staff must be available;

- the discarding areas must be planned;
- the bottom of the landfill must be waterproofed;
- the water table must be more than 2 metres below the bottom of the landfill;
- there must be no drinking water sources or wells in the vicinity of the site;
- chemicals must not be disposed of on these sites;
- the waste must be covered daily and vectors (insects, rodents, etc.) must be controlled;
- the landfill must be equipped with a final cover to prevent rainwater infiltration;
- leachates must be collected and treated.

Sanitary Landfill- Every method has its advantages and drawbacks.

	Advantages	**Drawback**
Sanitary landfill, trench method	Simple and inexpensive operating costs. Can be carried out using an existing municipal waste management system. Scavengers cannot access the health-care waste if the landfill is well managed.	The landfill must be secure, fenced in, and guarded. Scavengers and animals need to be controlled. A high degree of coordination is needed between collectors and landfill operators. Transport to the landfill can be a lengthy and costly operation. Risk of water pollution

NEWER TECHNOLOGIES:

Ozone (O3) can be used for especially pharmaceutical waste, water and air treatment. It is a strong oxidizer which breaks down to a more stable form (O2). But Ozone systems require shredders and mixers to expose the waste to the bactericidal agent.
Regular tests should be conducted to ensure that the microbial inactivation or elimination standard is met.

Promession: Promession is an innovative method of ecological burial. Its primary principles are preservation after death in organic form, and shallow burial in living soil that quickly converts a body to a form that is primed to foster new life.

Alkaline hydrolysis: It is a fast-upcoming process that converts body parts, specimens and cadavers into a decontaminated aqueous solution and destroys fixatives, hazardous chemicals and waste contaminated by prion. After the waste is loaded in the basket and into the hermetically sealed tank, alkali is added along with water at temperature of 127°C or higher and stirred. After digestion time of 6–8 h, by-products include mineral constituents of bones and teeth, solution of amino acids, sugars, soaps and salts. It can also destroy chemotherapeutic or cytotoxic agents and aldehydes (such as formaldehyde and glutaraldehyde) commonly used in hospitals.

Nanotechnology:

It is used to cleanse environmental air to improve indoor quality air and includes a photo catalyst with wide spectrum of light and is bactericidal and fungicidal. It utilises the energy from light to generate hydroxyl species and superoxide anion ($O2^-$) which decompose and oxidise toxic pollutants to carbon dioxide and water.

Membrane bioreactors

It combines the biological-activated sludge process with a membrane filtration step for sludge water separation.

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Box 1.2 UN Millennium Development Goals relating to health-care settings

Goal 4, Target 5 of the UN Millennium Development Goals aims at reducing by two thirds the death rate for children under five. Goal 5, Target 6 aims at reducing maternal mortality by three quarters.

Source : WHO

ORIGINAL ARTICLE

FINE TUNING BIOMEDICAL WASTE MANAGEMENT FOR IMPROVING PUBLIC HEALTH: ISSUE OF WASTE FROM VETERINARY SOURCE

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ABSTRACT

Health of a state is indication of development. Management of health of citizens demands proper policy, legislation, planning, monitoring and management of health. Since 1998, India has seen changes in the way biomedical waste is managed. But there is no evidence to confirm decrease in burden of disease. There is a huge gap among the states with respect to the quantity of waste reported. In spite of growth in consumption of medical consumables, the quantity of biomedical waste generation reported is not proportionate to population. Further, many of the animals which dye at farms due to various diseses is being disposed without any precaution and so are many rodents and dogs which die in urban area. This paper looks at opportunities to improve biomedical waste estimation, collection and disposal.

INTRODUCTION

India adopted first rule exclusively for management of biomedical waste in 1998. The rules resulted in establishment of network of Common Biomedical Waste Management Facilities (CBMWTF) to collect and dispose biomedical waste from Health Care Establishments (HCE). The new business flourished over the years all over the country. Table 1 gives biomedical waste generation in India from 2011 to 2015. But still there is no documented evidence of reduction in burden of disease.

Table 1 Biomedical Waste Generation in India from 2011 to 2015

Year	No. of HCEs	Biomedical Waste Generated (kg/d)	Biomedical Waste Treated (kg/d)
2011	151535	415,194.00	377,876.00
2012	159838	416,039.50	379,509.54
2013	168869	484,271.00	447,456.00
2014	169913	495,323.59	461,952.88
2015	188098	501,489.00	486,730.00

Source : Central Pollution Control Board (2017)

Biomedical waste generated depends on disease, diagnosis/treatment method and infection control policy/system adopted in health care establishment. The percapita waste generation in any health care establishment depends on the patients and diseases. Hence there is urgent need to estimate and check the waste generation reported by health care establishment.

The population of India on 2011 as per provisional population of totals census 2011, is 1,210,193,422 compared to a total of 1,028,737,436 in 2001 there by increasing the population of India by more than 181 million during the decade 2001-2011 (Census of India, 2011).

Placenta is one of the anatomical wastes generated during child birth of both humans and animals which need proper disposal. The weight of placenta generated by human and various domestic animals is given in **Table 2.**

Table 2 Weight of placenta of humans and various domestic animals

Sl. No.	**Placenta**	**Weight (kg)**
1	Placenta of humans	0.7 – 0.8
2	Placenta of cows/buffalo	4 -5
3	Placenta of sheep	0.5
4	Placenta of camel	5.75-6.0

Considering 73,787 births per day (Medindia, 2017) .Assuming biomedical waste of 0.7kg/birth, the weight of biomedical waste generated itself would be 51.6 t/day.

With increase in population, medical consumables market witnessed growth over past two decades. The country consumed 5.1 million disposable syringes in the year 2012 (Niir Project Consultancy Services 2014) there by disposing 76.5 t in 2012 assuming weight of each syringe as 15 gm.

Similarly considering estimated requirement of blood in the country is 10-12 Million units per annum (Loksabha questions, 2016) total weight of empty blood bags would be 800 – 960 t per year assuming weight of each bag as 80 gm.

The major consumables in human health care establishments are listed in **Table 3.** This needs monitoring to estimate the biomedical waste generated.

Table 3 Major consumables used in Health care

Sl. No.	Consumables
1.	Bandages
2.	Catheters
3.	Clothing & Garments
4.	Diagnostic Lights Consumables
5.	Dressings
6.	Electrodes
7.	Feeds, Nutritional Supplements
8.	Imaging Consumables
9.	Oral Care
10.	Paper Products
11.	Respiratory Consumables
12.	Skin Closure
13.	Spirometry Consumables
14.	Ultrasound Consumables
15.	Bedding Consumables
16.	Cleansing Sterilising Agents
17.	Compression Garments
18.	Defib Consumables
19.	Diagnostic Testing
20.	ECG Consumables
21.	Feeding Equipment
22.	Gloves
23.	Needles / Syringes / Cannulae
24.	Otoscopes Consumables
25.	Respiratory Consumables
26.	Skincare
27.	Sterilisation Consumables
28.	Surgical
29.	Thermometers
30.	Utensils
31.	Laboratory consumables

The pharmaceutical shops, animal farms, local bodies which generate biomedical/infected waste are yet to establish captive biomedical waste treatment facility or avail the service of CBMWTF. The supply chain with respect to pharmaceutical and cosmetic goods in Karnataka

is given in **Table 4.** A separate organization has issued authorization management of expired or discarded Medicines (Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drug along with glass or plastic ampoules, vials etc.) in Karnataka. But similar system is yet to be evolved all over the country.

Table 4 Supply chain with respect to Pharmaceutical and cosmetic goods in Karnataka

Particulars	2011-12 (31-03-2012)
Number of Manufacturers in the State	
Regular license	230
Loan Licenses	272
Cosmetic Licenses	059
Cosmetic Loan Licenses	024
Re packing Licenses	005
Approved Laboratories	015
Blood Banks	176
Blood Storage Centers	103
Number of Sales premises in the State	**26,658**

Source: Drugs Control Department (2017)

There is lack of statistics to explain fate of animals which have died due to disease. Many rodents and street dogs which die due to various diseases often become part of municipal solid waste while dead animals from laboratories are disposed in accordance with rules. The carcasses of poultry birds and animals which succumb to death during transportation or diseases are hardly observed in CBMWTF.

Opportunities

Considering the flourishing laws, activities and business there is huge potential to tap the opportunities to collect and dispose infected and uncollected biomedical waste.

The country saw tremendous increase in medical colleges, medical professionals, HCEs and pharmacies in past two decades thereby increasing consumption patterns of medical consumables. But the trend is not seen in the quantities of biomedical waste reported since adoption of dedicated rule to mage biomedical waste. Many small health care establishments with respect to humans and animals do not maintain register and report the statistics of deceases

to any government authority and hence many of minor ailments/injuries are not considered in reporting burden of disease.

The country has emerged as destination for medical tourism. But there is no research to establish per patient waste generated during major surgery, child birth and treatment of major ailments. Many urban local bodies still do not have proper abattoir and slaughter house. In spite of increase in meat consumption there no evidence of increase in formal abattoir and slaughter house. The practice of slaughtering in shops, houses, religious events continue without checking health of animals. It is common observation that many animals/birds succumb to death during transportation due to poor health. The animal farms which generate huge placenta, dead animals/birds, need to be brought under purview of the legislation. The biomedical/infected waste generated from more than one billion people of the country at household has not gained attention and disposed with municipal solid waste.

Generation of Persistent Organic Pollutants (POP) is proven beyond doubt during combustion of biomedical waste and concerned law stipulated specifications for incineration. Similarly notification/publishing legislation and guidelines for siting/controlling emission is not available for safeguarding public health.

RECOMMENDATIONS

1. Consumption pattern of medical consumables if not considered to cross check the waste generation reported. There urgent need to conduct research and publish market survey with respect demand and forecast of medical consumables consumption in the country.
2. Many small HCEs with respect to humans and animals do not maintain registers and report the statistics of deceases to any government authority.
3. There is no research to establish per patient waste generated during major surgery, child birth and treatment of major ailments. There is urgent need for research in this aspect.
4. The disposal of biomedical waste generated during slaughtering, transportation and death of animals need to be improved. The animal farms which generate huge placenta, dead animals/birds, need to be brought under purview of the legislation.
5. There is no research which correlates decrease in burden of diseases due to biomedical waste management from health care establishment. Hence there is need to carryout research in its aspect.
6. The biomedical/infected waste generated from more than one billion people of the country at household need attention and routed to proper disposal.

7. The Principle Extended Producers Responsibility (EPR) adopted with respect to e-waste shall be considered for producers of medical consumables.
8. Generation of Persistent Organic Pollutants (POP) is proven beyond doubt during combustion of biomedical waste and concerned law stipulated specifications for incineration. Similarly notification/publishing legislation and guidelines for siting/controlling emission from crematoriums may be considered in the country.
9. There is huge network of pharmaceutical shops in the country which is almost equal to number of HCEs from which expired drugs need to be disposed scientifically in accordance with existing law.

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ORIGINAL ARTICLE

"SITUATION ANALYSIS OF INFECTION CONTROL PREVENTION AND HOSPITAL WASTE MANAGEMENT PRACTICES TO EVOLVE IMPLEMENTATION STRATEGIES FOR SOUND MANAGEMENT AMONG DENTAL HEALTH CARE FACILITIES IN BENGALURU CITY"

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ABSTRACT

Background and objectives: Oral health care delivery is provided on an outpatient basis, ranging between simple examinations to placement of implants. In this course of providing care, the Dental Health Care Personnel (DHCP) are routinely at an increased risk of microbiological infections and they also generate a noticeable quantity of different categories of waste. Literature review has consistently shown poor compliance to standards and also ambiguity in the legal frame work. Hence, this research was planned with an objective of conducting a situation analysis of Infection Control, Prevention and Waste Management as the core areas and to arrive at implementation strategies.

Methods: The study was conducted among the Dental Health Care Facilities of all the categories in Bengaluru, adopting mixed method research strategies. A comprehensive and validated tool consisting of26 sections and 254 items covering elements of IPC and WM including quantification, costing and FGD guidelines formed the study tool which presented acceptable alpha and kappa scores. A Focus group discussion was conducted to explore the issues, concerns and experiences pertaining to the core areas amongst the DHCP. Direct observation check lists, verification of records and Interviews were the methods followed for data collection by trained research assistants and researcher scholar. A statistically decided sample of 285 small sized establishments, whole population of 11 large establishments, and available 20 medium sized establishments formed the study units. The study period ranged from 2010 to 2015.

Results: The results demonstrated poor compliance to standards for ICP and WM in all categories of DHCFs. A Large number of DHCF's had a sub optimal level of functioning for

the ICP and WM domains. Unsegregated waste was commonly observed and around 6.615 kg of waste was generated per Cat A per day and an average of 36.2 grams of waste was generated per patient per day from Category A and 45.7 grams from category C. An amount of Rs.8.10 was spent for infection control and waste management per patient in Category A and an amount of Rs.18.81 was spent in Category C. DHCP expressed that a commitment from top level management would contribute in improving systems and also in their willingness to undergo training. The findings from all sources were analyzed by referring the best evidence available, after which guidelines were developed and the plan of action as implementation strategy was also put forth.

Interpretation and conclusion: The DHCF's demonstrated unsatisfactory compliance to standards for ICP and WM. Unsegregated waste, alarming quantities of hazardous waste and the favorable attitude demonstrated by DHCP indicated the need for interventions in order to improve the system. The implementation strategy so developed is recommended for the improved and sustainable systems for all categories of the DHCF.

Key words: Oral health, Dental waste, Infection control, Dental Waste management, CDC, Body fluids, Hepatitis B, Immunization, out patients, saliva.

LIST OF ABBREVIATIONS

AIDS-Acquired Immuno Deficiency Syndrome,BMW-Bio Medical Waste,CDC-Centre for Disease Control and Prevention,CTF-Common Treatment Facility,DHCF-Dental Health Care Facility,DHCP-Dental health Care Personnel,DHCW-Dental Health Care Waste,HBV-Hepatitis B Virus,HCA-Health Care associated Infection,HCV-Hepatitis C virus,HCW-Health Care Waste,

HCWM-Health Care Waste Management,HIV-Human immunodeficiency syndrome,ICP-fection Control and Prevention,IDA-Indian Dental Association,KSDC-Karnataka State Dental Council,

KSPCB-Karnataka State Pollution Control Board,MoH-Ministry of Health,MOU-Memorandum of Understanding,NGO-Non GovernmentalOrganisation,PCB-Pollution Control Board,PPE-Personal Protective Equipment,PPP-Public-Private Partnership,SLOT-Strength Limitation Opportunity Threats,SOP-Standard Operating Procedure,TOT-Training of Trainers,WHO-World Health Organisation,WM-Waste management

1: INTRODUCTION

1.1: Back ground information

Health care facilities are considered by people as 'Temples' for the curing of ailments. Hence health care providers have a huge responsibility of ensuring the sanctity of the place and are bound by the ethical obligation "To do no harm". Hospitals have the significant potential to contravene this ethical obligation, if utmost importance is not given to the areas of infection control, prevention and waste management. The incidence of cross infection, occupational exposure and also nosocomial infections to be more precise, are higher if this area is inadequately addressed. There has been profound demand from the public for improved health care and on other side an increased awareness among professionals towards occupational exposure and cross infection (1). The emergence of hospital acquired infection, rising incidence of hepatitis B and HIV and increasing land and water pollution, leading to an increase in the possibility of many diseases and air pollution due to the emission of hazardous gases, compelled the authorities to give a serious thought about infection control and health care waste. Since both infection control and health care waste are interrelated many of the international guidelines treat them as a single entity.

1.2: Dental Health Care - Infection control and waste management

A dental hospital or a clinic is a complex multi-disciplinary system which consumes a substantial quantity and quality of materials and items for the delivery of dental care. The demand for dental care has resulted in a rapid increase in the number of dental health care facilities, ultimately generating dental health care waste. However the quantity of dental health care waste generated in a Dental Health Care Facility (DHCF) is lower as compared to medical health care waste and also varies in the quality of waste generated.

The Dental Health Care Personnel (DHCP) is routinely at risk of cross- infection and occupational exposure while providing care. Most of the human microbial pathogens are isolated from oral secretions and many of these cause serious diseases. As a result of repeated exposure to microorganisms present in blood and saliva, the incidence of certain infectious diseases has been shown to be significantly higher among dental professionals than observed for the general population. The infections are Hepatitis B, Hepatitis C, tuberculosis, herpes simplex infections, influenza and a variety of dermatological bacterial and mycotic diseases (2)(3).

Dental health care facilities are also potential areas for generating hazardous waste which could have implications on dental health care personnel, patients, waste management facility employees and scavengers. The irony is that, though DHCFs do generate health care waste of large quantum, more so of different categories, mention about these categories of waste and their management guidelines has not been made in the Biomedical Rules, 1998 of Government of India. Medical health care facilities provide treatment to the patients on an outpatient and inpatient basis whereas, in dental health care facilities, treatment is provided predominantly on an outpatient basis. Yet the infections that the DHCP and their patients are at risk of are similar to general facilities. Hence, the dental health facilities need to follow certain guidelines for infection control, prevention and waste management. However user friendly guidelines or manuals relevant to our country are needed that a DHCP can follow.

1.3: Guiding principles

Five guiding principles are widely recognized for effective and controlled management of wastes and have been used by many countries while developing their policies, legislation and guidelines. Two of these principles that have relevance to health care waste are "precautionary" and "duty of care" principles.

POLICIES, LEGISLATION AND REGULATIONS:

India is a member of almost all major Multilateral Environmental agreements two of the four relevant to health sector is Hazardous material and atmospheric emissions. There are over 500 active agreements and MOUs to which India is signatory. For the focus area of research the ones relevant are - Stockholm Convention on Persistent Organic Pollutant and Basel Convention on control of transboundary movement of hazardous waste and their disposal. Montreal Protocol on Ozone depleting substances for atmospheric emissions, Vienna Convention for the Protection of the Ozone Layer, Kyoto protocol and Rotterdam Conventions. Stockholm Convention on Persistent Organic Pollutants, 2001: The convention is an international agreement by the nations of the world to address the global chemical pollution. The objective of the convention is to protect human health and the environment from POPs. These are termed as 'Poisons without passports'. They have the potential to travel long distances via water and air. The characteristic features are the toxicity, persistence and lipophilicity of these chemicals.

The Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their disposal: The convention was adopted in 1989 in response to concerns about toxic waste from industrialized countries being dumped in developing countries and countries with economies in transition. Recent emphasis is on complete implementation of treaty commitments, promotion of the environmentally sound management of hazardous waste and minimization of hazardous waste generation.

Air (Prevention and Control of Pollution) Act, 1981: The objective of the Act was to provide prevention, control and abatement of air pollution. The Act was basically aimed at the industrial pollution and automobile pollution.

Environment (Protection) Act, 1986- Which is considered as an umbrella legislation designed to provide a frame work for the coordination of Central and State authorities established under water and Air Act. Whereas decision were taken at the United Nations Conference on the Human Environment held at Stockholm in June, 1972, in which India participated, to take appropriate steps for the protection and improvement of human environment. And whereas it is considered necessary further to implement the decision aforesaid in so far as they relate to the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property. It covers from Radio -Active substances disposal to use of plastic bags.

Hazardous waste (Management and Handling) Rules 1989- These rules classify used mineral oil as hazardous waste under the Hazardous Waste (Management and Handling) Rules, 2003 that requires proper handling and disposal. Organisations to seek authorisation for disposal of hazardous waste from concerned State Pollution Control Boards (SPCB) as when required. The rule was amended in 1998, 1999, 2001, 2002, 2003, 2004 and 2006.

Biomedical waste (Management and Handling) Rules 1998- The services in the medical field are developed ten bound. Naturally the waste as a bye product to medical is also increased by ten bounds. With a view to control the indiscriminate disposal of hospital waste / biomedical waste, the Ministry of Environment and Forest, Government issued a notification on Bio Medical Waste Management under the Environment (Protection) Act. These rules stipulate on procedure to be adopted for segregation, disinfection, deformation, transportation and disposal for different categories of waste generated for all the establishments generating such waste.

Biomedical Waste Management Rules, 2016- The notification was issued by Ministry of Environment, Forest and Climate Change, Government of India on 28th March, 2016. To implement the rules more effectively and to improve the collection, segregation, processing, treatment and disposal of these bio-medical waste in an environmentally sound management

thereby, reducing the bio- medical waste generation in an environmentally sound management thereby, reducing the bio-medical waste generation and its impact on the environment, the Central Government reviewed the existing rules. The Rule clearly specifies waste that is not included under the rule and also duties of occupier generation biomedical waste. The types of waste are categorized into four different colors representing option for disposal.

Environmentally Sound Management of Mercury Waste Generated from Health Care Facilities – A guidelines document issued by Central Pollution Control Board, Ministry of Environment and Forests on 31st of January 2012. The document is useful to all stake holders for environmentally sound management of mercury waste, generated from health care facilities and other sources in the country. The further literature search resulted in limited studies at the national level to understand the intricacies of the research focus with no standard template to collect data, poor awareness , below standard practices and also unfavorable practices. Literature at the international also revealed, most of the countries to have guiding principles, training manuals, protocols for safe practices published by either by Government or professional bodies, which was not true for our country.

2: AIM AND OBJECTIVES

2.1: Aim

To conduct situation analysis of infection control prevention and hospital waste management practices to evolve implementation strategies for sound management among dental health care facilities in Bengaluru City.

2.2: Objectives

1. To conduct a situation analysis of health care waste management systems and infection control practices in different categories of dental health care facilities in Bengaluru city.
2. To assess cost appropriate for Health Care Waste Management (HCWM) system and Infection Control Prevention (ICP) practices for the different categories of dental health care facilities.

   To evolve evidence based guidelines, standard operating procedures and implementation strategies for sustainable, sound management of health care waste management and infection control practices for different categories of dental health care facilities.

3: METHODOLOGY

Outline of methodology to address above research questions:

Status of ICP and DHCWM- Situation analysis of the systems both at macro and process level in different categories of dental health care facilities utilizing a validated direct observation check list, interview and verification of records.

Focus group discussion with dental health care personnel to elicit concerns, issues, challenges.

Appropriate cost to establish an appropriate system in different categories of dental health care facilities- details of capital cost, operating/recurring cost for infection control and waste management among sample of dental health care facilities will be collected to arrive at cost involved expressed as unit cost and total cost

Guidelines- training manual, standard operating procedures, IEC materials will be developed relevant to findings.

A mixed method approach including quantitative and qualitative methods was planned to address the research questions.

The study was conducted through 2010 to 2015 among different categories of dental health care facilities adopting both quantitative and qualitative research strategies. The details are described accordingly**.**

Study area: Bengaluru city

Study period: 2010- 2015

Study duration: 3 years after the approval of proposal

Study setting: Dental health care facilities, differing in categories.

Definitions:

- Category A (Large sized dental facilities) - "Facilities that deliver dental education for various specialties apart from providing dental health care services"
- Category B (Medium sized dental facilities) – "Facilities attached to a medical/dental establishment that includes dental dispensaries, outreach centers, mobile dental clinics"
- Category C (Smaller sized independent facilities) - "Dental Clinics/ Practices"

Study design: Mixed research methods (Quantitative and Qualitative)

- Descriptive cross sectional survey
- Focus group discussion

4.1: Phases in Methodology

The study was undertaken in various phases as below

4.1.1: Phase I- Preparatory phase

Time duration: 6 months

4.1.1a: Submission of the proposal for Ethical clearance

4.1.1b: Development of tools: Semi quantitative interview cum observational tool was developed

4.1.1c: Validation of tool

4.1.1d: Pilot Study (includes developing informed consent form)

4.1.2: Phase II- Identification of dental health care facilities/ preparation of sampling frame

Time duration: 3 months

4.1.3: Phase III- Data collection, analysis and presentation of findings

Time duration: 2 years

4.1.3a: Macro and Process area

4.1.3b: Quantification

4.1.3c: Costing

4.1.3d: FGD

4.1.3e: Data analysis

4.1.4: Phase IV: Development of Implementation Strategies - Guidelines, Standard Operating Procedures, Plan of Action (presented in result section)

Time duration: 1 year

The proposal was submitted to Ethical Review Board of MS Ramaiah Medical College and Teaching Hospital, and clearance was sanctioned – MSRMC/ ERB/2010 dated 11th August 2010. (Annexure 2)

4.1.1b: Tool development:

Methodology of Tool development

Identification of Variables:

The study incorporates four components:

1. Infection control and prevention practices
2. Waste management practices
3. Costing
4. Quantification

As a general rule in the first phase it was decided to enumerate all the variables that had to be included in the tool for infection control and waste management. Therefore with reference to CDC guidelines 2003 and WHO publication on Practical guidelines for infection control in

health care facilities 2004 and Practical infection control in Dentistry by Cottone's. The following domains were considered:

1. Hand hygiene
2. Use of personal protective equipments
3. Appropriate handling of patient care equipment and soiled linen
4. Prevention of needle stick injuries
5. Environmental cleaning and spills-management
6. Appropriate handling of waste

Enumeration of the variable related to each domain followed by division of categories and sub categories.

For ex. Composite variable- Hand hygiene

Variables- hand washing facilities, hand drying facilities, steps in hand asepsis.

Sub variables- specific tasks related to each variable.

Hence the tool consisted of six composite variables. Each of these variables were clearly defined in terms of objectively measurable tasks. Care was taken to explicitly define the variables and description of the methods by which the information is collected to ensure reliability. Each variable where ever warranted was operationally defined. After enumeration it was phrased into statements and sequenced to maintain some kind of order. The tool was divided into macro areas and process areas to ease data collection. The variables included in macro areas required investigators to verify records and process area required direct observation of the facility and specific task. The investigator had to enter the code given in the box which eased data entry and analysis.

SCALES OF MEASUREMENT:

Since categorical data was being generated it was decided to adopt the nominal scale ie. Yes or No option though they differed qualitatively. Numbers were used to identify categories but with no quantitative significance. The scale used for measuring composite variables was termed as composite scale. Hence the tool at this stage had 25 sections and 284 items or 6 composite variables with 25 variables and 284 sub variables (Annexure 5)

The obtained raw score was used to estimate percentage efficiency by using the formula- Obtained score/total score X 100.

Additionally section on costing, quantification and FGD guide was included.

Costing: All the probable expenses incurred towards infection control and waste management was enumerated. The list included labour cost, material cost, cost for training and immunisation and other direct and indirect costs. Data collection was by record verification and interview to calculate capital cost, recurrent cost, and cost per patient / DHCF. (Annexure 7 and 8)

Quantification of waste: Different categories of waste were listed out to record quantity generated per department and establishment. (Annexure 6)

Two methods were planned:

Standard weight method: Most of the categories of dental waste generated qualify to be counted in number. Hence for such categories, standard weight was arrived at by adopting following steps. For example wt. of one lead foil is 0.635mg, (arrived at by weighing the lead foil using three standardised weighing scales and calculating average) therefore if in one of the sampling unit, 20 lead foils are generated per day on an average then 0.635x 20 will be the quantity of lead waste generated by the sampling unit studied per day.

Actual weight method: For other categories of waste where above method does not apply weighing scale with precision of 0 .0001kg was adopted.

Focus Group Discussion:

Target Group: Dental Health Care Personnel

The following were the objectives for discussion by which the required information was collected.

i. To explore the concerns and experiences of DHCP regarding health care waste and ICP
ii. To Identify relevant intervention strategies
iii. To develop relevant IEC activities
iv. To Identify problems in on-going activities and to suggest appropriate solutions to those problems
v. To collect information regarding issues like management of mercury spill, accidental needle stick injury, any different system for disposing of certain categories of waste etc.

METHOD OF DATA COLLECTION:

Direct Observation, verification of records

Computation: Macro area section had five domains and the scores were grouped to arrive at one composite score to be called as Total Macro area score. The scores of sub variables were grouped to obtain one main variable score. The option for scoring was yes = 1 and No= 0.

Example: Category 1- Availability of written documents pertaining to policy and committees (4 sub variables) , Category 2- education and training (10 sub variables), Category 3- immunization programme (3 sub variables), Category 4- exposure prevention and post exposure management (5 sub variables) and Category 5- system for dental unit water lines (4 sub variables).

Total Macro area score= 4+10 + 3+5+ 4= 26 (A)

Obtained score= 15 (B)

Efficiency Score (C) = B/A X 100

15/ 26 X100= 57.69%

The efficiency for Total Macro area was 57.69%

Similar groups were derived and the composite scores considered for analysis are

a. Total Macro Score

b. Total Process Score (c +d)

c. Total ICP Score

d. Total Waste Management Score

Where ever applicable domain wise scores are also expressed. The scores obtained were between 0 to 100%. The DHCF's were grouped as follows:

0-25%, > 25% - 50%, > 50% - 75%, > 75% -100%.

Distribution of DHCF's revealed that majority of them cluttered between 0-25% and > 25 % to 50%. In order to have sizable numbers in each of the category, it was decided to dichotomize into 2 groups of score as 0- 50% and > 50- 100%.

Grading: Since Infection control and Dental health care Waste is still evolving in dental sciences operationally and conservatively facilities scoring more than 50% in each of the respective domains were graded, defined as system with optimal functioning (efficiency).

Efficiency score > 50% as Optimal,Efficiency scores < 50% as Sub-optimal.

Review of literature and consultation with experts opined that in current epidemiological situation of Infection control and health care waste in dental sciences even 50% can be considered optimum. The further analysis of data from Table 10 to 50 is presented based on above categorization.

Descriptive statistical analysis: All the quantitative measurements such as duration of establishments, patients per day, number of DHCP, number of dental units were expressed as Mean, Standard Deviation, Median and Inter Quartile Range along with Ranges. The categorical variables were expressed as percentages.

Analytical statistics: The Shapiro Wilk Tests of Normality were considered. Chi-Square test of significance was employed to test for associations for categorical variables. The rows and columns were clubbed until we got 2/2 table, if the assumption for chi square failed, Fishers test was applied whenever more than 20% of expected cell values are less than 5.

Pearson correlation was computed to measure for any correlation between Total Macro Score and Total Process Score across different study units with level of significance fixed at < .05 level.

FGD

Development of codes: After giving repeated readings to the transcript data, we were able to arrive at following codes. The codes developed are categorized into deductive and inductive codes. Some of the inductive codes emerged for "demands" and "suggestions". (Table 49 and 50 in Annexure 12)

CATEGORIES:

Perception - what the participants comprehend by means of understanding OR knowledge about hazards, risk associated with poor management of dental health care waste and about different categories of DHCW

Experience – any particular instances good or bad that the participants have encountered pertaining to DHCW

Concerns- any particular area or issue that the participants have pertaining to DHCW

Demand- as expressed by the participants certain requirements for establishing good systems.

Suggestion - any suggestions given for improving systems.

PRESENTATION OF FINDINGS:

The results are presented in the following manner:

Section A: Description of study units

Section B: Situation analysis of DHCF expressed as macro domain and process domain with respect to ICP and DHCWM.

Section C: Quantification of Dental Health Care Waste

Section D: Costing related to ICP and DHCWM

Section E: Analysis of Focus Group Discussion

Section F: Implementation strategy

4: RESULTS AND DISCUSSION

Table 1: Description of Basic Characteristics of study units based on categories of DHCFs expressed

Basic Characteristics	Category A n=11		Category B n=20		Category C n=285	
Variable	Median	IQR	Median	IQR	Median	IQR
Duration of establishment (Yrs)	22	(21-23)	21.5	(21-22)	10	(5-10)
Patients per day	113	(40-234)	11	(9-35)	4	(2-8)
DHCP	398	(271-492)	7	(6-12)	6	(2-6)
Dental Units	230	(156-315)	2	(2-3)	1	(1-2)
Working hours	6.6	(6.5- 7)	7	(5-7)	7	(5-8)

The median duration of year of establishment was 22 for large facilities and 10 years for smaller facilities which implies that 50% of the larger facilities and smaller facilities were working since 21 and 23 years and between 5 to10 years respectively. Whereas larger facilities had more number of patients, DHCP and dental units as compared to smaller facilities which is because of the difference in the organizational and functional difference.

Section B: Situation analysis of ICP and DHCWM.

Scoring pattern for each unit was classified as optimal and sub optimal. This section presents a situational assessment for three categories of DHCF for macro and process domain.

* N=99 for Category A, 20 for Category B, 285 for Category C

Table 2: Description of Basic Characteristics of study units based on categories of DHCFs expressed

Macro domain			
Category of DHCF	**Suboptimal**	**Optimal**	**Total**
	n(%)	**n(%)**	**n (%)**
Large	50 (58.1)	36 (42)	86 (100)
Small	185 (65.8)	96 (34.2)	281(100)
Total	235 (64)	132 (36)	367 (100)
Chi square= 7.373, df = 1, P value = .025			
Note : 17 DHCF's were not included in analysis due to information not provided Suboptimal <50%, Optimal ≥50% Refer to list of abbreviations			

Functioning of DHCF in area of macro domain was significantly higher among large facilities than smaller facilities which were statistically significant. This implies that larger facilities had better system ie presence of committees, policies, training, immunization and prevention exposure protocol. The total score also indicated 64% of the Dental health care facilities had suboptimal level of functioning.

Table3: Status of Process domain for ICP and DHCWM across category A and C DHCFs

Process domain ICP and DHCWM			
Category of DHCF(N=384)	Suboptimal n (%)	Optimal n (%)	Total n (%)
Large	55(62)	33 (37.5)	88 (100)
Small	136 (42.2)	146 (51.8)	282(100)
Total	191 (51.6)	179 (48.3)	370 (100)
Chi square= 5.471, df = 1, P value = .019 Note : 14 not included in analysis due to information not available			
(Pearson correlation) r= 0.785, P=.01 (2 tailed) between Macro and process areas of ICP and DHCWM.			

There was statistically significant difference in the level of functioning in the process domain of ICP and DHCWM between large and smaller facilities with 37.5% of the larger facilities in optimal level of functioning as against 51.8% of smaller facilities. The variables in the process area were hand hygiene, PPE's, Environmental disinfection, disinfection and sterilization of patient care equipments, dental radiology, segregation, disinfection, worker safety. The result also indicated a positive correlation between macro and process domains of ICP and DHCWM indicating the association between Macro area and process area variables within the Dental Health Care Facilities.

Table 4 Percentage of DHCP adopting best practices for gloving and mouth mask in the process area of Infection control

Sl.no	**Variables**	**N**	**Yes**	**No**
1	Changes gloves when integrity was hampered	149	123 (84.56)	26 (15.4)
2	Changed gloves when procedure was beyond 1 hour and visibly soiled	91	35 (38.46)	56 (61.5)
3	Changes mouth mask when visibly soiled	302	64 (21.6)	238 (78.8)
4	Changes mouth mask when the procedure was beyond 1 hour	93	25 (26.88)	68 (73.1)

85% of the DHCP were aware of the infectious potential of a breached glove but unaware of the lowered efficiency of gloves when used for prolonged duration. Best practice for mouth mask was followed by 22% to 27% of DHCP.

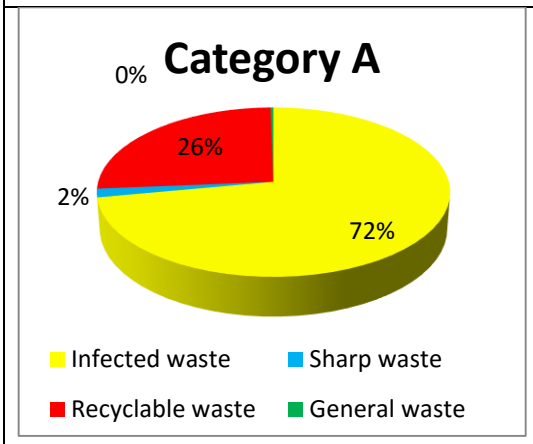
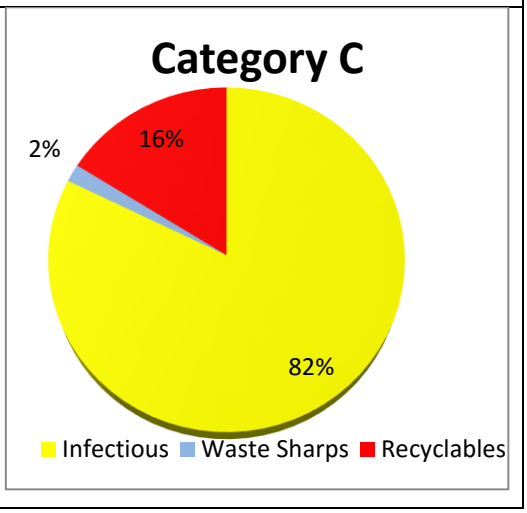
Figure 1 Quantum of different categories of DHCW among Category A DHCF expressed in percentages	**Figure 2Quantum of different categories of DHCW among Category C DHCF expressed in percentages**
	

Table 5 Cost details of DHCFs expressed in Rupees

Cost description	**Category A (Large) n=4**		**Category C(Small) n=32**
	ICP	**DHCW**	**ICP and DHCW**
Total cost among units of DHCF observed	2270920	1039389	1083587
Annual Total cost per DHCF	567730	259846	33862
Annual Capital cost per DHCF	165205	4943	1421
Annual Recurrent cost per DHCF	402525	254904	32440
Cost per month per DHCF	33543	21242	2821
Cost per patient/ day/ DHCF	5	3.1	18.81
Cost per day among /DHCF	1118	708	94

Total patients per day among large DHCF= 887 (Patients per day per DHCF=222)

Total patients per day among small DHCF= 150 (Patients per day per DHCF=5)

Number of days considered per month= 30

Costing for Category C includes ICP and WM

The costs for larger DHCF were higher as compared to smaller DHCF, however the cost per patient was higher in smaller units with Rs. 18.81 as against Rs. 8.1 in larger DHCF's. This explains the differing organizational structure between different categories of DHCF's. However details of cost towards training and immunisation was not included owing to non availability of information.

Table 6 Components of Recurring cost for waste management expressed in Rs. among Large DHCFs

Waste management	Capital cost	Consumables	Staff	Monthly service	RC - Monthly	RC- annual cost
Institution1	6057	7140	47.62	8,500	15687.2	188244
Institution 2	3738	18958	38.10	-	18996.1	227952
Institution 3	3525	18958	120	12,000	31078	372936
Institution 4	6451	11600	107	7,500	19207	230484
Total	**19,771**	**56,656**	**312.72**	**28,000**	**84,968**	**10,19,616**

Note-

Institution 1- did not have any records for water bills as it was combined with medical setup

Institution 2- did not have records for paying monthly charges.

Institution1, 3 and 4 had chair side bins, therefore calculating space cost for waste management was impractical

Utility cost is not considered for waste management (water and electricity bills)

FGD:

Totally five discussions were conducted with target participants as housekeeping staff, dental assistant and nursing staff and dentists at different centers.

FGD1 and FGD2 (Housekeeping staff and Attenders)

FGD3 and FGD 4 (Nursing staff)

FGD 5- (Private practitioners)

A summary of relevant findings from data generated in the focus group interviews is presented. Details of code, categories, themes are included in annexure along with pictures and Sociograms.

Presentation of key findings:

Altogether 82 codes, 16 categories and 7 themes were derived from analysis.

Perception: Codes related to perception were- awareness pertaining to categories, segregation, and color coding and poor practices. The data showed that participants were able to collectively enumerate 25 types of waste. But participants from housekeeping group alone could enlist 7 types and participants from nursing staff could enlist around 25 types of waste. The number of infectious and hazardous waste enlisted by group representing housekeeping staff was very low.

Color coding: participants in housekeeping group enlisted 3 color coded bins but participants in the nursing staff group were able to discuss about 5 color coded bins and a separate bin with bleaching solution.

Segregation: The key finding was that some of the participants were experienced to different system of waste segregation ie the single bin system and multiple bin system. They were able to able to differentiate and appreciate the previous and existing waste management system. Two of them commented about the system being very poor in their respective departments. When asked to rank the previous and existing waste management system most of them did give a higher rank to the existing different bin system, though some members did feel the need for improvement. Participants in both groups were able to discuss about poor practices that they had seen and identified departments that that had poor segregation practices. Participants also mentioned about need for separate bins for each kind of waste.

Concerns: Participants expressed concern in terms of poor compliance to segregation by few departments and specifically by students. Participants also discussed about poor practices leading to infections which could spread through air and enlisted risk participants to be students, staff and patients. They also discussed about issues with poor segregation and burning of plastics could be hazardous. They spoke about personal care while handling instruments.

Another area of concern was managing non-segregated waste to which participants resorted to doing it themselves at the end of the day. While few participants also discussed about how they would collect penalty from students or at times they would resolve to attenders to segregate it. Infections, especially HIV and HBV were frequently spoken about by all participants. They had concern over increased chances of getting infection through stick injury and therefore stressed on need for testing the all Patients for HIV and HBV before starting treatment. Poor work practices amongst Attenders was discussed and their specific action of handling waste without gloves becoming victims of needle stick injuries. Similarly poor work practices demonstrated by Post graduates "*using gloves only they pick phone and even they will put hand in the mouth"* and recapping of needles, use of rusted instruments by students were concerns expressed by the participants. Participants were able to identify poor practices in a few departments. They also expressed concern over no immunization protection given, small bins and non-availability of gloves was another area of concern expressed by participants. One of the participants discussed about how she had sleepless nights when she experienced needle stick injury, until unless she confirmed that the patient's blood reports were negative.

Experience: Every participant had experienced needle stick injury during their work time and one of the participants reported an injury by fall of instruments on the feet. All of the participants mentioned about washing the injury under running water. when discussed about blood spill management, participants shared that they would just wipe it with cloth with ungloved hands and throws the cloth as infected waste. But participants responded that they would use hydrogen peroxide to wipe with cloth, gauze using gloved hands and dispose it as infected waste.

Similarly even the blood and urine samples were discarded directly into the sink without any pre treatment by both participants. Their discussion on the action taken post needle stick injury showed the participants wouldn't give any extra attention to it, where as the discussion amongst participants varied between - we will ignore, to washing the finger under running water and squeezing out blood. They would also use spirit at times and take TT. Some of them would find out the history of patients.

Participants also expressed that they would broom the spilled mercury with regular waste whereas participants discussed about availability of mercury spill kit, collection in fixer containing bottle and handing it over to external buyers but the utility of mercury collected by the buyers was not known. Lead waste was considered infectious and was stored separately.

Suggestions:

Participants suggested measures to improve systems. The first suggestion given by Participants was to educate students as they possessed unfavorable attitude to waste management. They also suggested that they should be immunised against infectious diseases. Participants suggested having education and training for all personnel at all levels with primary focus on students as they have unfavorable attitude and attenders because they are at risk. They discussed having such training programmes at regular intervals at least once in 3 months using videos. As they have seen students using rusted instruments, it was felt that the institution should have a system of distributing instruments to students. The suggestion to have a register to record needle stick injuries was given by participants. They also felt that if it was made mandatory by governing and accrediting bodies like DCI and NAAC, there would be definite improvement in system.

Demands: Immunisation was the first demand that emerged as inductive code. They insisted that the Head of the Institution should be responsible for good systems. Knowledge and skill gained by attending continuing education programmes and workshops should be applied to improve systems. Advanced equipments meant for improving systems should be procured by the institutions. There should be sufficient supply of gloves and mouth masks. All patients should be screened for HIV and HBV especially those attending departments of oral surgery, orthodontia and conservative. Participants1 felt that all departments should have Nursing staff and attenders as they are asked to perform their duties. Both participants felt that there should be a policy regarding compulsory immunisation to all personnel and they wouldn't mind if the expenditure was deducted by their salary. Issues were raised against the non issual of appropriate sized bins, good quality gloves, discontinuation of HBV vaccination, no system of vaccination, PEP, mixing up of waste in some of the areas. All participants felt the need for extensive training and were ready to undergo annual health check up if organized.

Impression:

Strength: System of waste segregation was in place though at some areas mixing was reported. The participants had favorable attitudes which were evident in their response to need for training and request for facilities to improve systems. Level of awareness pertaining to waste categories and its segregation was good. They did have concern for their health. The group dynamics was good as they collectively in full strength identified one of them to coordinate needle stick injury.

Lacunae/ weakness: Level of awareness was poor in the areas of mercury and blood spill management. Training of personnel, vaccination, and infrastructure were inadequate and requires attention.

KEY FINDINGS:

1. No specific guidelines about DHCW in the regulatory frame work
2. No manual available for ICP specific to our scenario
3. Dental profession has been a low priority issue to policy makers
4. Poor supervision and monitoring of DHCF by prescribing authority
5. Adoption of standard procedures for Infection control – who is the prescribing authority and monitoring agency

Root causes for the problem:

1. Lack of commitment from stake holders

Reflected as:

A. Macro area: unsatisfactory compliance at Macro level both for the system and monitoring (Committees, policy, guidelines, training, immunization, post exposure prophylaxis)

B. Process areas: Lack of protocols for infection control and prevention and waste management procedures among more than 60-70% of the DHCF

- Poor work practice controls for prevention of needle stick injury/ occupational exposure to blood and OPIM
- Non compliance to PPE
- Poor system for decontamination of patient care equipments
- Insufficient equipments for ICP and WM
- Poor sterilization and monitoring and supervision
- Poor practices for DUWL/ environment infection control
- Unsatisfactory segregation / decontamination/ deformation/ waste sharps management
- Unsatisfactory workers safety practices

C. FGD:

Unfavorable attitude of DHCP (students, faculty) towards infection control and waste management

Poor practices followed by students

Lack of facilities and training and guidelines

Poor commitment from top level (No PEP, PPE, increased incidence of needle stick injury)

Unfavorable attitude of CTF personnel

Poor services offered or No services by CTF in spite of completing formalities

No clear guidelines

D. Quantification:

1. Increased quantity of non-segregated waste
2. Mixing of all kind of waste adding to increase in the total volume of incinerable waste
3. Alarming generation of hazardous waste with no guidelines for its management

Based on the above, a detailed plan of action is presented with the objective of providing -

"Safe and healthy environment for the patients and DHCP and community at large"

Action plan for implementing best practices for infection control and sound management of dental health care waste among DHCFs in Bengaluru

Outcome	Activity	Year		
		1	2	3
Advocacy efforts for strengthening implementation of ICP and DHCW system.	Presentation of the research findings to all stake holders	✓	✓	
	Initiate action to integrate DHCW into existing Biomedical Waste Management Rules- 2016	✓		
	To advocate for developing ' National guidelines for ICP and DHCW" hazardous waste generated in DHCF into		✓	✓
	To collaborate with CTF and KSPCB for arriving at guidelines for DHCW with unclear disposal option	✓		
	To include compulsory module for dental students in the curriculum	✓		
	To include component of ICP and DHCW during inspections from apex bodies	✓		
	To make mandatory earning of credits to earned by dental practitioners on regular basis	✓		
Capacity building of DHCP to follow guidelines for best practices for ICP with adequate awareness, competencies and attitude	Developing training modules specific to roles of DHCP	✓		
	Developing educational charts specific to tasks/ focus areas/ DHCP	✓		
	Sensitization programme to all stake holders on " Importance of ICP and DHCW" and identified gaps	✓		
	Training of Master Trainers for " Infection control and waste management for DHCP"	✓	✓	
	Planning of training sessions Zone wise to cater to private dental practitioners	✓	✓	
	Reinforcement training of Dental practitioners in "Comprehensive infection control and dental health care waste including legal issues	✓		

Outcome	Activity	Year		
		1	2	3
	Sensitization programme to Deans on " Institutional responsibilities in providing safety environment through ICP and DHCWM"	✓	✓	✓
	Initiate training of students in Dental Institutions	✓	✓	✓
Strengthen service Common Waste Treatment Facility	To assist in developing a mechanism for the CTF personnel in lifting waste on a regular basis	✓		
	To create awareness amongst among dental practitioners to register with Dept. of Health and Family Welfare	✓	✓	✓
Establish a model DHCF at different category of delivery system to demonstrate best practices of ICP and DHCW	Identify site for establishing model setting for all categories of DHCF for learning and benchmarking	✓		
	To stabilize/ identify for funding for establishing model site	✓		

5: CONCLUSION

The research was planned to assess the situation of infection control and waste management among Dental Health Care Facilities in Bengaluru city. The research findings can be utilized to initiate collective actions from stake holders so as to establish sound practices for ICP and DHCW management system.

1. The DHCF's observed, demonstrated poor compliance to recommended standards for infection control prevention and dental health care waste management at macro and process areas.
2. Standard guidelines relevant to our scenario are not available.
3. The DHCF's generated large quantities of hazardous waste.
4. The DHCP demonstrated favorable attitude towards patient safety and occupational health and additionally a willingness to contribute in improving the system by undergoing relevant training.
5. The DHCF's with the level of functioning between 25 % and 50% spent Rs 8.1/- and Rs 18.81/- in Large and small categories consecutively towards infection control and waste management
6. The guideline document to address the above gaps and findings is based on professional experience, internationally accepted guidelines and extensive literature search which are based on scientific evidence.
7. A systematically and logically developed plan of action can be utilized as an implementation strategy for improving ICP practices and sound management of DHCW in Bengaluru city.

6: RECOMMENDATIONS

Health care waste management in dental care institutions deserves important consideration. There is need to bring together all institutions under a professional banner and design and develop policies, Implementation strategies, SOPs, training curricula, training manuals .It is strongly recommended that a nodal person is identified in large and medium sized dental care institutions across the city of Bengaluru to strengthen, plan, monitor and evaluate healthcare waste management and infection control systems. Additionally following are specific recommendations:

1. To conduct Expert Committee workshops and stake holder consultations, aimed at building consensus on the guidelines and the standard operating procedures.
2. To advocate intersectoral coordination in order to promote environmentally sound management of waste generated in health care facilities.
3. To arrive at SOP's and guidelines for DHCF's of different categories relevant to each DHCP
4. To advocate capacity building, both short term and long term measures for strengthening systems for ICP and DHCW
5. To develop training manuals to cater to all levels of DHCP to facilitate ICP and DHCW management.
6. To conduct multicentre studies and to understand the issues pertaining to ICP and DHCW in more detail.
7. To facilitate future research in exploring the management options for Plaster of Paris, Mercury, Lead and Fixer.
8. To advocate towards developing National guidelines of Infection control practices and Waste management for Dental Health Care Facility.

There is scope and potential to share the findings of this study to all members of dental profession, dental professional institutions across the country including Government, professional councils and bodies.

Acknowledgement: The authors acknowledge the Management of GEF, Dean of Ramaiah Medical Teaching College, Vice Chancellor and Pro Chancellor of Ramaiah University of Applied Sciences, Dean Faculty of Dental Sciences, Institutional Doctoral Committee members and Management of participating dental colleges and Private practitioners for the support and encouragement extended. A special note of heartfelt gratitude to Professor NS Murthy, Dr Gautham Sukumaran, Dr Hemanth Thapesay, Mr. Shivraj and Dr Shalini Nooyi.

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The problem–solution tree

The problem–solution tree is a simple method to identify problems, their causes and effects, and then define objectives for improvement that are achievable and appropriate for the specific conditions of each health-care setting. The problem–solution tree is performed as a group activity through the following steps:

1. Discuss any major aspects of the current situation where water supply, sanitation, healthcare waste management and hygiene targets defined for the health-care setting are not met. Write each one in large letters on a small piece of paper (e.g. A6 size) or a postcard.

2. For each major problem, discuss its causes by asking "why?" For each of the contributing problems identified, ask "why?" again, and so on until root causes for each problem have been revealed and agreed. Write all the contributing problems in large letters on a piece of paper or postcard and stick them on a wall, arranged in a way that reflects their relation to each other and to the major problem.

3. For each of the contributing problems noted, discuss possible solutions. Check that these solutions contribute to solving the major problems identified by asking "what?" to identify the effects of the action. Some solutions proposed will probably have to be abandoned because they are not realistic given current conditions, or because they do not have sufficient impact on the major problems.

4. Once a number of feasible solutions have been agreed, they should be phrased as objectives. For each objective, the group can then discuss and agree on a strategy (how the objectives can be reached), responsibilities (who will do what), timing, resources and requirements. 2.7 Phased improvements

Source : WHO

RESOURCES AND INFORMATION

USEFUL REFERENCES ON BIOMEDICAL WASTE RESEARCH 2015-2017

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RESOURCES AND INFORMATION

USEFUL YOUTUBE VIDEO LINKS

Dr. Shankar R
Associate Professor, Department of Community Medicine, Vinayaka Mission University, Salem

1) Ecosteryl - Environmental friendly biomedical waste treatment - https://www.youtube.com/watch?v=2ckHP-U-mZQ&feature=youtu.be

2) Hazards of improper management of Biomedical Waste - https://www.youtube.com/watch?v=STqS0Yf8yOM&feature=youtu.be

RESOURCES AND INFORMATION

INDIAN SOCIETY OF HOSPITAL WASTE MANAGEMENT

(Founded – 2000, registration under the Societies Registration Act XXI of 1860, Reg No. 36939 of 2000)

The Government of India published a Gazette notification on 20 July 1998 making all personas who generate, collect received, store, transport, treat, dispose or handle medical waste in any form responsible for handling the medical; waste without and adverse effect to human health and the environment. Consequent to the publication of above Gazette Notification on Bio-Medical Waste Management. It is mandatory for all hospitals and health institutions to implement the rules.

Since Hospital Waste Management is a perpetual problem, it was felt that there should be an all India Organization/Society comprising of experts/specialists from various disciplines involved in Hospital Waste Management. This Society should provide conceptual guidance and oversee scientific research for further development.

With this important aspect in mind, the Registrar of Society at Delhi was approached for registration of the 'Indian Society of Hospital Waste Management (ISHWM)' and the Society came into existence on 10th April 2000 and registration under Societies registration Act XXI of 1860 with Registration Number 36939.

The aims and objectives of the Society are as follows:

(a) To promote and advance the knowledge in Environmental Protection with special reference to Hospital Waste Management/ It also envisages promotion and improvement in public health. Protection to the environment, hospital and 'individual through the practice and education in the subject's dealings with the said subject.

(b) The subject of Environmental Protection and Hospital Waste Management involves multidisciplinary approach and involves active participation by specialists of various disciplines such as pathology, Microbiology, Hospital Administration, Preventive & Social

Medicine. Therefore, it will function to bring together specialists from various disciplines under a roof with a common goal a personal and environmental protection.

(c) To propagate education and inculcate awareness in hospital as well as general population.

(d) To advance research in various field, connected with Environmental Protection and Hospital Waste Management.

(e) To function as an interface with Industries involved in designation/manufacture of bio-medical waste disposal equipment/appliance for R&D development India.

To fulfill and further the above objectives the Society shall

(a) Hold periodically meetings, seminars, workshops, training courses and annual conference of the members of the Society.

(b) Conduct workshops, training courses etc. separately for the benefit of the beneficiaries such as general public, hospital waste handlers, patient & their relatives.

(c) Publish and circulate a journal on Hospital Waste Management and Environmental protection.

(d) Maintain a Library at the location of the permanent officer as a when established.

(e) Generate funds from all possible sources. The funds so generated will be utilized for advance in the knowledge of disposal of waste and environmental protection. Scholarships and Awards for outstanding contributions will be judged on merit by a special board of officers nominated from time to time.

(f) Propose to the Government the laws and regulations in respect of disposal of waste from the hospitals and environmental protection.

(g) Create and assist State-wise branches to propagate the objectives all over the country in a methodical and systematic manner.

EMBLEM & LOGO

The Emblem of the Society has been aptly designed to convey the message of environmental protection by confining hazardous hospital waste. The concept of the Emblem is:-

Hospital waste management uses four colours namely – Green, Black, Yellow and Red (Coding colours) used for bags to collect and dispose off hospital waste.

Hands: The two figures over the top and bottom denote the hands in light brown outlined with black to denote the hands, which stand for the control and management of waste.

Syringe: The syringe has been used as a symbol to represent hospital waste due to its extensive use in clinical practice.

Biohazard: Hospital waste is a serious biohazard hence the universally accepted logo for biohazard appears in the backdrop.

Tree & the Blue background: denote the Eco friendliness, which is very important while disposing of hazardous, waste.

Summary: the Logo depicts the hospital waste (syringe), which is a biohazard to the community being efficiently managed (by hands) in an environmental friendly (tree and blue background) manner.

ISHWM: Indian Society of Hospital Waste Management.

LETTER TO EDITOR

Dear Editor,

Heartfelt congratulations for publishing worthwhile articles on Bio Medical Waste Management for the past fifteen years and best wishes for your continued success.

The article titled "Useful tips for undertaking situation analysis of Health Care Waste Management in health care settings in India" published in your esteemed journal, volume 15, issue 01, Sep 2016 was indeed very helpful for me to undertake a situational analysis in a tertiary health care setting.

Liquid waste generated from health care setting which is considered as hazardous waste can be infectious waste like blood and body fluids, laboratory wastes, pharmaceutical liquid waste, chemically hazardous formaldehyde, mercury, solvents, radioactive isotopes; or from cleaning, housekeeping and disinfecting activity. The management of such waste is either confusing or conflicting. While one of your article titled "Initiatives of BMW Management in department of health, Government of Karnataka" had mentioned about liquid bio medical waste management, the bottlenecks in management of the same is essential for in depth understanding. Hence inclusion of more articles on liquid bio medical waste management and handling guidelines, the legal aspects involved therein will be highly appreciated.

Although mercury elimination in healthcare setting is advisable, mercury containing equipment are still widely used. But there exists a lacuna in management of hazardous waste containing mercury especially with respect to disposal of mercury. I would request your good self to consider publishing more articles on mercury disposal management.

My heartfelt wishes to the team for indexing of the journal.

Warm regards,

Dr. Archana S
Town: Kurumbapet
Union Territory: Puducherry.

GUIDELINES FOR AUTHORS

JOURNAL OF THE INDIAN SOCIETY OF HOSPITAL WASTE MANAGEMENT

1. Journal of Indian Society of Hospital Waste Management publishes original articles, case reports, review articles, editorials, contemporary issues/agendas book reviews and other related scientific information towards Safe Management of Health Care Waste.

2. Articles are accepted for publications with the understanding that their contents. (All or in part) have not been published and will not be published elsewhere, except in the abstract form or with the consent of the Editor. Journal of Indian Society of Hospital Waste Management does not accept any responsibility for the statements made by the authors. The Editorial Board has the right to introduce such changes in the write-up as may be considered necessary for effectiveness of communication.

3. Following CERTIFICATES (Original Single copy) must accompany the articles.

(a) Certificate from Authors

(i) Certified that I/we have not used any information or material from official documents graded 'restricted' and above or any 'classified' information obtained in any my/our official capacity in the preparation of the article of the article title.

(ii) Certified that this manuscript contains no matter that is libelous or otherwise unlawful, or invades individual privacy or infringes on any proprietary rights.

(iii) All authors certify that they have made substantive and intellectual contributions to the article and assume public responsibility for its content.

(iv) It is also certified that none of the material; in this manuscript has been published previously or is currently under consideration for publication elsewhere.

Signatures of

First author	Second author	Third author
Date_____	Date_____	Date_____

1. **MANUSCRIPT** must be typed in double space throughout, on one side of good quality white bond paper of size 22x28 cm or A4 size with margin on both sides. Words should be hyphenated at the end of a line. Three copies, soft or hard should be submitted along with 3 sets of illustration and the entire text in MS Word format on a CD. Authors must retain a copy of all the above material, as the Journal cannot be held responsible for its loss due to any reason. The material should be enclosed in a large envelope, superscripted 'Article for Publication Not to be Folded', and sent under registered cover to Editor in Chief, Journal of Indian Society of Hospital Waste Management, Health Care Management Cell, Department of Community Medicine, M. S. Ramaiah Medical College, Bangalore - 560 054. (Karnataka).

5. **PROCESSING**: Material received for publication will be acknowledged. The article may be reviewed by referrers. When required, one copy of the typescript, suitably modified, will be sent to the principal author for revision and resubmission in duplicate. Accepted articles will be published in their turn. Reprints (at least 10) of each article will be sent free cost to the FIRST author. Articles not accepted for publications will be returned by ORDINARY post.

6. **AUTHORSHIP: Should be restricted to persons who have made sufficient contributions to (a) conception and design (b) drafting the article or revising critically (c) final approval of the article to be published. All conditions must be ideally met. The order of authorship should be joint decision of all the coauthors.**

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(a) Title page: gives the title of the articles a short title for page heading, type of article (original article, case report etc), name(s) of the author(s), affiliations of author(s), place of work,

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(b) Abstract and keywords - The abstract is a synopsis of the main article in about 200 words and gives an opportunity to the author to induce the reader to go through the article. It must give the purpose, methods, results and conclusions of the study, giving facts and not descriptions. Speculative surmises, and references to other works on the subject should be included. Avoid abbreviations. No abstract is required for case reports. Below the abstract give not more that 5 key words using terms from Medical Subject Headings list of Index Medicus.

(c) Text - The text should be divided into sections, e.g. Introductions, Materials and Methods, Results and Discussion. Each should have it individually and must not be mixed with other. Ensure that all references, tables and figures are cited in the text.

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(e) Legend - to illustrations should be brief (rarely exceeding 40 words), but must explain the salient features of the illustrations.

(f) Illustrations - should be presented only of they depict something new or unusual. They should be serially numbered in the order of their mention in the text, irrespective of their nature viz. photograph, drawing or chart, using only the word 'figure' and not diagram, graph etc. Type a label indicating the top ( ), the short title of the article and the figure number on a piece of paper and past in on the back of the illustrations.

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JOURNAL OF THE
INDIAN SOCIETY OF HOSPITAL WASTE MANAGEMENT

Volume – 16 Issue – 01
September 2017

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