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Compliance with the Bio-medical Waste Management Rules & Effect of Training – A Systems Perspective of Health Care Facilities in Ramanagara District, Karnataka

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Abstract:

In India, the Bio-medical Waste Management Rules, 1998 were revised in 2016 and later amended in 2018 and 2019. Accordingly the scope of Health Care Facilities (HCF) coverage was enlarged. Training is an important requirement under these Rules. A survey of 105 HCFs in Ramanagara district, both government and private, spread across all four taluks and located in urban as well as rural areas was carried out. Nurses received training in higher proportion of HFCs in rural areas and in the government sector compared to those in urban areas and private sector, which is statistically significant. However, training of doctors, nurses, pharmacists and lab technicians was not found to be associated with the practice of segregation of bio-medical waste. Regression through origin, showed the quantity of BMW generated by a HCF is positively associated with number of outpatients, location and type and negatively with number of inpatients, with R2 0.51. Only about one third of the registered private clinics were using the services of the Common Bio-Medical Waste Treatment Facility (CBMWFT) operational in the district. Bar coding system is yet to be adopted. Liquid waste is being treated by about 82% of the HCFs before disposing. Both the vehicles of the CBMWFT are GPS enabled. In addition to training of staff, availability of funding and necessary items like bins, covers, needle cutters etc. will facilitate efficient management of BMW in the district.

Key Words Common Bio-Medical Waste Treatment Facility; Health Care Facility; Bio medical waste, training; regression analysis; Maridi, Ramanagara.

Introduction

Health care services are essential to reduce morbidity and also mortality and improve health status. However,

the process of delivery of health care generates bio-medical waste (BMW), as a bye-product. If not treated scientifically and disposed properly, BMW can cause injuries and also be a source of a number of infections, some of which could be deadly. In order to reduce the harmful effects of BMW, the Government of India has notified the Bio-Medical Waste (Management and Handling) Rules, 1998 published vide notification number S.O. 630 (E) dated the 20th July, 1998. These rules were superseded by 'the Bio-Medical Waste Management (BMW) Rules, 2016.' According to these Rules a Health Care Facility (HCF) means a place where diagnosis, treatment or immunisation of human beings or animals is provided irrespective of type and size of health treatment system, and research activity pertaining thereto. Important changes in 2016 Rules include a) coverage of HCFs is more pervasive; b) duties of occupiers listed; c) categories of BMW reduced to four from 10; d) treatment and disposal mandatory for all HCFs; e) on-site treatment is allowed by HCFs if there is no CBMWTF within a distance of 75 KMs; f) format for annual report prescribed; in terms of HCF covered. (Central Pollution Control Board and National Productivity Council 2017). The BMW Rules also stipulate use of bar coding to account and track the waste being sent out of the premises and disposed through common biomedical waste treatment facility. The vehicles transporting BMW should have GPS to monitor their movement. Due to the change in coverage under the ambit of BMW Rules, number of HCFs increased from 764 to 11460 in Himachal Pradesh (Sood 2016). The BMW Rules, 2016 were further amended in 2019 to include compliance with output discharge standards of liquid waste by 31st December 2019, by HCFs with less than 10 beds (Ministry of Environment Forest and Climate Change 2019). In 2017 India generated on an average about 559.1 tons of bio-medical waste per day, out of which, it is estimated that around 518.6 tons is treated. Thus about 14782.5 tons of BMW is not treated in a year. Karnataka, a state in the southern part of India, tops among the states in India producing with 67.3 tons per day (Central Pollution Control Board 2019). With a Cumulative Annual Growth Rate (CAGR) of 7%, India will produce an estimated 777.5 tons of BMW. This offers an attractive investment opportunity (ASSOCHAM 2018).

In this backdrop, this paper presents an assessment of compliance of HCFs with the BMW Rules in Ramanagara district of Karnataka state in India. Ramanagara district was carved out of the erstwhile Bengaluru (earlier Bangalore) Rural District on 23 August 2007. The district comprises four taluks (sub-district areas) namely

Channapatna, Kanakapura, Ramanagara and Magadi of the undivided district. Bengaluru is the capital of Karnataka state. The Ramanagara district lies between the north latitude of 120 14' to 130 and 11' and east longitude between 770 3' to 770 8'. The study district has a population of 1,082,636 (urban - 24.7%; rural – 75.3%) as per Census 2011. In terms of population it is ranked 28th and in terms of population density it is ranked 13th in the state. The district has 73 Government Health Care Facilities (HCF) comprising a) one district hospital; b) four sub district HCFs/Community Health Centres (CHC); c) 61 Primary Health Centres (PHC); d) four urban clinics. The private sector HCFs include 25 hospitals; 112 nursing homes/clinics and 30 diagnostic laboratories registered with the Directorate of Health.

Materials and methods

A total of 105 HCFs (hospitals, nursing homes, clinics) were surveyed with help of a structured questionnaire. The survey covered six Urban Local Bodies (ULB) and 106 villages, covering all four taluks namely Channapatna (13.3%); Kanakapura (36.3%); Magadi (31.4%) and Ramanagara (19.1%). Share of private HCFs is 71.4% and the remaining are government HCFs. While 60% are located in the urban areas, the remaining are in the rural areas of the district. Interviews were conducted with relevant officials of the District Pollution Control Board (DPCB); Common Bio-Medical Waste Treatment Facility (CBMWTF) and District Health Office (DHO) of Ramanagara district. The CBMWTF was also visited.

Profile of Sample Hospitals

Location: Out of the 30 Government hospitals 16.7% are in urban areas comprising one district hospital; two taluk hospitals and 2 Primary Health Centres (PHC). The remaining (83.3%) are in rural areas consisting of 20 PHCs and 5 sub centres. In case of the private HCFs 77.3% are in urban areas and the remaining in rural areas.

Number of Beds: While 17.1% of the sample HCFs have no beds (Government – 6.7%; private – 21.3%), about 57.1% of the HCFs have beds between 1 and 5. Another 19% have between 6 and 20 beds, while the reaming 6.7% have more than 20 beds. Two HCFs with 100 and one with 150 beds are in the urban areas and both are in the Government sector. Distribution of the HCFs by bed strength and taluk are presented in Table 1.

Table 1: Distribution of HCFs by Bed Strength in Ramanagara District – By Taluk

(Percentage)

S. NO.	NUMBER OF BEDS	TALUK				TOTAL
		Channapatna	Kanakapura	Magadi	Ramanagara	
1	NIL	0.0	18.4	33.3	0.0	17.1
2	1 to 5	57.1	55.3	48.5	75.0	38.1
3	6 to 10	42.9	15.8	12.1	15.0	18.1
4	21 to 30	0	7.9	3.0	5.0	4.8
5	100	0	2.6	3.0	0	1.9
6	150	0	0.0	0.0	5.0	1.0
	NO. OF HCFs	**14**	**38**	**33**	**20**	**105**

Outpatients per day: In case of 33.3% hospitals, number of outpatients was between 1 to 19 and 44.8% hospitals have out patients between 20 to 50. Of the remaining 19.1% have more between 51 to 200 and the 3.8% have more than 200 outpatients. All the four HCFs with more than 200 out patients are in the Government sector and in urban areas.

Inpatients per day: Majority (61.9%) of the sample hospitals don't admit inpatients. Proportion of zero patients HCFs is 69.8% in Government and 50% in private. While 17.1% have 1 to 5 another 13.3% have between 6 to 20 inpatients. Remaining 7.7% have an inpatient load of more than 20. HCFs with NIL inpatients is higher in the rural areas (74.7%), while it is only 30% in the urban areas.

Deliveries/Surgeries: Deliveries/surgeries are conducted in only 14.3% of the sample HCFs. The proportion is the highest in Ramanagara taluk and the lowest in Magadi taluk. Proportion of HCFs conducting deliveries/surgeries is relatively higher in urban areas (15.9%) in comparison with rural areas (11.9%). While 33.3% of the government HCFs conduct deliveries/surgeries only 6.7% of the sample private HCFs do them.

Results and Discussion:

The present study adopts 'systems frame work' for assessment of compliance with the BMW Rules by the HCFs in Ramanagara district. The Bio-medical Waste Management System of Ramanagara district can be depicted as shown in Figure 1.

The findings are presented with respect to the key subsystems namely a) Health Care Facilities (HCFs); b) Common Bio-medical Waste Treatment Facility (CBMWTF); c) District Pollution Control Board (DPCB) and d) District Health Office (DHO).

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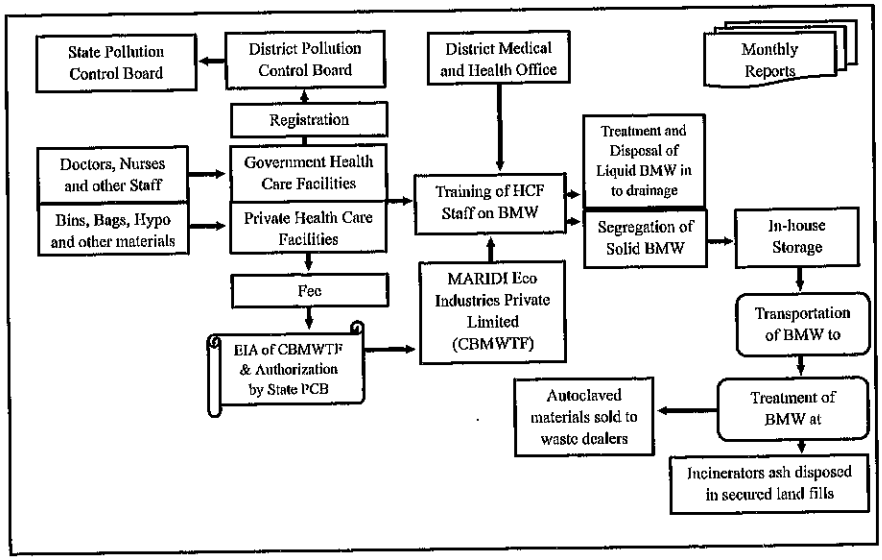
Figure 1: The Bio-Medical Waste Management System of Ramanagara District



Note: *BMW – Bio Medical Waste; CBMWTF - Common Bio-Medical Waste Treatment Facility; EIA – Environment Impact Assessment; GPS – Global Position System; HCF – Health Care Facility*

Health Care Facilities

Salient findings with respect to a) training of staff; b) BMW management practices and c) quantity of bio-medical waste generated were analysed in the following part.

Training

Training is an important means of creating awareness, which in turn is necessary for correct BMW management practices. Pre and post assessments of training interventions of hospital staff in Bengaluru in Karnataka state (Ahmed et al 2016) and Hyderabad in Telangana state (Swathi et al 2018) report an increase of their knowledge about BMW management, which is was also statistically significant. Imchen et al (2017) observed that the healthcare workers who received training are 5 times more likely to show correct practices of waste segregation as compared to those who did not receive training, in a tertiary hospital in Lucknow city, in the India state Uttar Pradesh.

The BMW Rules 2016, stipulate that staff of health care establishments (HCFs) and common bio-medical waste treatment facilities (CBMWTF) be trained on segregation, collection, storage, transportation, treatment and disposal of bio-medical wastes.

Among the 105 sample HCFs, doctors were trained in 81.9%; nurses in 42.9%; pharmacists in 18.1% and lab technicians in 14.3%. Status of training by category and location of the HCF are shown in Table 2.

Table 2: Number of HCFs Reported Training of Staff in Ramanagara District – By Location

S. NO.	STAFF CATEGORY	NUMBER OF HCFs REPORTED TRAINING			
		Urban		Rural	
		Yes	No	Yes	No
1	Doctors	53	10	33	9
2	Nurses	20	43	25	17
3	Pharmacists	11	52	8	34
4	Lab technicians	8	55	7	35
	TOTAL NO. OF HCFs	**63**		**42**	

Nurses were trained in higher proportion of rural HFCs (55.6%) compared to urban HCFs (44.5%).

Status of training by category and type of HCF are shown in Table 3

Table 3: Proportion of HCFs Reported Training of Staff in Ramanagara District – By Type

S. NO.	STAFF CATEGORY	NUMBER OF HCFs REPORTED TRAINING			
		Government		Private	
		Yes	No	Yes	No
1	Doctors	23	7	63	12
2	Nurses	23	7	22	53
3	Pharmacist	10	20	9	66
4	Lab technicians	10	20	5	70
	TOTAL NO. OF HCFs	**30**		**75**	

Similarly, nurses in higher proportion of government HCFs (76.7%) received training compared to the HCFs in private sector (29.3%).

The difference by location and also type of HCF was found to be statistically significant at 0.01 level. For location the Pearson Chi-square is 7.94 and DF=1. For type of HCF the Pearson Chi-square is 19.6 and DF=1. The difference in training, by location and type, of other categories of staff was found not statistically significant at 0.01 level.

BMW Rules is the most widely covered topic in the training (81.9%) followed by segregation of BMW (45.7%) and management of sharps (21.9%).

BMW Management Practices

Segregation of Solid Waste: Majority (82.9%) of the sample HCFs stated that they segregate bio-medical waste (BMW) from other solid waste. Segregation is relatively better among the HCFs in urban areas (85.7%) in comparison with the HCFs in rural areas (78.6%). A study of 121 HCFs in seven districts of three states viz. Andhra Pradesh, Maharashtra and Uttar Pradesh in India has also reported higher proportion (86%) of HCFs in urban areas segregating BMW compared to 61% of HCFs in rural areas (Rao 2018). Similarly segregation is marginally better in private HCFs (84%) in comparison with the Government HCFs (80%). Pearson Chi-square test shows that the difference is not statistically significant for location as well as type of HCF.

Practice of segregation of bio-medical waste by HCFs was analysed with respect to training of doctors, nurses, pharmacist and lab technician in the HCFs. Pearson Chi-square test shows that segregation practice is not associated with training of any of the four staff considered.

Use of Colour Coding: According to the BMW Rules 2016, yellow bins are to be used for (a) Human Anatomical Waste; b) (b) Animal (Laboratory) Anatomical Waste; c) Soiled Waste items contaminated with blood, body fluids; d) expired/ discarded medicines; e) chemical waste; f) chemical liquid waste; g) Microbiology, Biotechnology and other clinical laboratory waste, etc. Red bins are meant to store **Recyclable Contaminated Wastes** generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes etc. White translucent and puncture proof containers should be used to store needles and sharps like scalpels. Black/Green bins are used for general waste.

Also almost all sample HCFs (97.7%) reported segregating BMW as per the colour coding. Use of different colour coding is shown in Table 4.

Table 4: Use of Colour Code for Segregation by Sample HCFs in Ramanagara District

(Percentage)

S. NO.	BIN COLOUR	USE OF COLOUR CODING FOR SEGREGATION			
		LOCATION		TYPE	
		Urban	Rural	Govt.	Pvt.
1	Yellow	52	30	22	61
2	Red	47	23	17	54
3	Black/Green	45	21	17	50
4	Others	2	2	1	2
	TOTAL NO. OF HCFs	**52**	**33**	**24**	**61**

Management of Sharps: Needle cutters are being used by 63.2% and needle destroyers by 26.4%. Contaminated Needles are disinfected using hypo solution before disposing by 87.4%. A post training evaluation of 116 HCFs in eight districts covering all four revenue divisions of Karnataka state in 2014 reported non-containment of sharps in 34.7%, 23.4%, 26.8% of small, medium and large HCFs, respectively (Gadicherla et al 2016).

Liquid Bio-medical Waste: Blood, mucous and other infectious waste is treated and neutralized by 81.9% of the sample HCFs, before disposing. In case of 33.3% of the sample HCFs the liquid waste flows in to sewerage, while from 40.0% of the HCFs it goes in to open drains and in the remaining it goes in to other places.

Use of CBMWTF Services: A common biomedical waste treatment facility (CBMWTF) collects BMW from 86.2% of the sample HCFs in Ramanagara district for treatment and disposal. The coverage of urban HCFs is 81.5%, while it is 93.9% in the rural HCFs. While almost all (95.9%) are covered among the Government HCFs, only 82.6% of private ones are serviced by the CBMWTF. As per the 2016 Rules, the BMW should not be stored more than 48 hrs at HCFs. Some of the sample hospitals maintained that the CBMWTF sometimes does not collect waste within 48 hrs. A review of the "Status of Implementation of the Biomedical Waste Management Rules, 2016, in the entire state on 20-03-2017 (Karnataka State Pollution Control

Board 2017) also pointed out such lapses on the part of CBMWTFs in the state.

Other Solid Waste: Other solid (municipal) waste is collected by the Municipality in case of 45.4% hospitals and 29.9% dump in municipal bins.

Quantity of Solid BMW

Among the 87 sample HCFs that segregate BMW, the average BMW produced is 4.82 kgs/day. The sample Government HCFs produce on an average 6.92 kgs/day, higher compared to 4.0 kgs/day generated by the sample private HCFs. On the other hand the HCFs in urban areas produce 5.44 kgs/day, which is higher compared to 3.76 kg/day produced by those in rural areas. However, the 't' value for difference in means show that the difference for location as well as type of HCF, is not statistically significant. Distribution of sample HCFs by quantity of waste generated is shown in Table 5.

Table 5: Distribution of Sample HCFs by Quantity of BMW Generated in Ramanagara District

(Percentage)

S. NO.	QUANTITY OF BMW (kg/day)	LOCATION		TYPE		TOTAL
		Urban	Rural	Govt.	Pvt.	
1	1 kg and below	18.5	18.2	12.5	20.6	18.4
2	2 to 5	55.6	75.8	62.5	63.5	63.3
3	6 to 10	14.8	3.0	12.5	9.5	10.3
4	10 to 20	9.3	0.0	4.2	6.3	5.7
5	21 to 50	1.9	3.0	8.3	0.0	2.3
	NO. OF HCFs	**54**	**33**	**24**	**63**	**87**

Number of inpatients and outpatients treated are significant determinants of the quantity of BMW generated by a HCF (Tesfahun et al 2015). Association between the type of HCF and production of BMW was found to be statistically significant in Taiwan (Cheng et al 2009) and in Uttarakhand state in India (Thakur and Ramesh 2018).

In this study, a multivariate analysis, using regression through origin, was carried out using quantity of BMW/day as the dependent variable. Four independent variables namely number of outpatients, number of inpatients, location of HCF and type of HCF were found to be significant. The R^2 was 0.515. While inpatients showed negative association,

remaining three variables showed positive association. The beta and 't' values of the four independent variables are shown below.

S. NO.	INDEPENDENT VARIABLE	BETA	't' value
1	No. of outpatients	0.451	4.347
2	No. of inpatients	-0.165	-1.671
3	Type of facility (Government =1)	0.245	2.555
4	Location of facility (Urban = 1)	0.358	4.329

CBMWTF

Maridi Eco Industries (MEI) Pvt. Ltd has set up a Common Hazardous Waste and Bio-Medical Waste Treatment Facility (CBMWTF) at KIADB Harohalli Industrial Area, Phase – II, Harohalli Village, Kanakapura Taluk, Ramanagara District. The CBMWFT of MEI provides scientific disposal of bio-medical waste treatment and disposal services, not only to the HCFs in Ramangara but also, those located in Bengaluru Urban, Bengaluru Rural, Mandya districts, catering to approximately 25,000 beds. The total waste handling capacity of the facility is 25 TPD, of which 20 TPD is accounted by BMW. The facility has (a) 1 x 500 kg/hr rotary kiln incinerator for treatment of hazardous waste and biomedical waste and 2 x 250 kg/hr static incinerators for treatment of biomedical waste, (b) Autoclave – 5 TPD, and (c) Shredder – 1000 kg/hr. up to 20 TPD of Bio-Medical Waste. (Maridi Eco Industries 2018). MEI has an Effluent Treatment Plant also and the treated water is used for circulation in incinerators for control of air pollution.

As per the records of MEI, their CBMWTF caters to 70 Government and 100 private HCFs in Ramanagara district. Two vehicles fitted with GPS, which is mandatory as per the latest BMW Rules, collect BMW from HCFs and transport it to CBMWTF for treatment.

MEI has conducted one district level training in 2017-18 for both Govt. and private hospital staff. One person from each hospital had attended the training programme. It has also organised three training programmes during the last year for their own staff.

MEI charges Rs. 5.50 to 6.00 per bed for private HCFs. For private clinics a fixed amount of Rs. 2500 per month is charged. In case of government hospital the charges are fixed depending on the level. They are as follows:

- District Hospital: Rs 8000/ month.

- CHC: Rs 3500/ month.
- PHC: Rs 2500.00/ month.

Out of a total 112 registered private clinics in Ramanagara only 31.3% clinics are using the services of MEI. Remaining 77 private clinics and 30 odd diagnostic centres are yet to be enrolled with MEI. Non-usage of services of MEI is similar to other districts. In Uttara Kannada district of Karnataka state about 28.8% of the 805 HCFs did not register with a CBMWTF (Ismail 2018).

Pollution Control Board

The State Pollution Control Board gives authorization to the HCFs to handle BMW and the CBMWTF to collect, transport, treat and dispose the waste collected. The district PCB has coordinated with the District Health Office (DHO) to conduct a training programme on BMW for the HCFs in the district during 2017-18. In collaboration with MEI, PCB organised a one-day training in 2017-18.

According to the Form IV-A, a mandatory submission by the district PCB to State/Central PCB, while 1071Kgs of BMW is generated per day, about 89.5% is collected by MRI. The HCFs with bed generate 2.3 times more Bio-medical waste compared to HFCs with no-beds. Further details are summarised in Table 6.

Table 6: Summary of Bio-medical Waste Management in Ramanagara District (2018-19)

S. NO.	ITEM	VALUE
1	Total number of HCFs	475
2	HCFs (Hospitals and Nursing Homes) with beds	152
3	Total number of beds	1869
4	Number of HCFs/occupiers authorised by PCB	114
5	BMW generated by bedded HCFs per day	748 kgs
6	BMW generated by non-bedded HCFs per day	323 kgs
7	Total BMW generated per day	1071 kgs
8	BMW collected, treated and disposed by CBMWTF (Maridi)	958 kgs
9	Number of occupiers submitted annual reports for the previous calendar year	104
10	Veterinary institutions using captive facilities (deep burial pits)	113

Some of the bedded HCFs and most of the non-bedded HCFs are yet to be authorised by PCB.

District Health Office

The QCM section of the DHO office of Ramanagara district has organized over 55 to 60 trainings for all government hospitals during their facilitation visits since 2016. The DHO also submits the monthly/annual reports of various government HCFs to the PCB. As per the 4th quarter Kayakalpa Report, out of the total 73 government HCFs, annual reports were submitted for 47 HCFs.

Conclusion

This is one of the very few studies which looked at the entire district level system of biomedical waste in India. 'The quantity of waste generated by the HCF is dependent on four variables namely i) number of outpatients; ii) number of inpatients; iii) location of HCF and iv) type of HCF. The association is statistically significant. This study found that training of nurses to be positively associated with the practice of waste segregation. Training of other staff, however, did not show association with segregation practices. It implies that training alone will not be able to bring in change in the segregation behaviour of HCF staff. Other enabling factors such as adequate funding, supervisor and availability of basic items such as bins, plastic covers, needle cutters/ destroyers and hard plastic containers with hypo to disinfect sharps will facilitate the transition. Liquid waste is being treated by about 82% of the HCFs before disposing. The vehicles of the CBMWFT in the district are GPS enabled to ensure tracing of their movement. Bar coding by the HCF of their waste, another mandate of the BMW Rules 2016, is yet to catch up in the district. There is also an urgent need to ensure that the HCFs, not yet using the services of the CBMWFT available in the district, to enrol and dispose of their BMW scientifically.

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