Original Research Paper

Hospital Administration

EVALUATION OF BIOMEDICAL WASTE MANAGEMENT IN A TERTIARY CARE HOSPITAL – A STUDY AT VIMS & RC

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ABSTRACT Bio medical Waste (BMW) collection and disposal has become major concern for the medical and general Community. Improper waste management is hazardous to health care workers, patients, general Public and largely the environment. **Aims & Objectives:** i) To evaluate the practices of BMW Management at source of generation and transportation among different patient care areas at Vydehi Hospital ii) To analyze the quantity of waste generates iii)To assess the Knowledge, Attitude and Practices(KAP)among health care personnel regarding waste management. Methodology: It is a direct Observational and cross-sectional study which was conducted for a period of 12 months at VIMS & RC (Vydehi Institute of Medical Sciences & Research Centre). It was evaluated under 4 categories, with a checklist of 20 parameters among 40 patient care areas. Simple random sampling technique is used to select the study subjects for the KAP questionnaire. **Results:** At VIMS & RC, the BMW management mean observation was at the level of "Condition of waste receptacles" were good (95.79%) & least observation noted with "waste transportation" (52.5%). The total Infectious waste generated was 0.135kg/bed/day and the hospital has got separate colour coded bins in each ward for collection of waste. The safety measure taken by health care workers regarding KAP of biomedical waste management was not satisfactory among Class IV Employees and it was not due to unavailability of personal protective measures but because of un-awareness of health hazards which may occur due to improper waste management practices. **Conclusion:** It is concluded that there should be strict implementation of waste management policy, proper training and motivation regarding BMW management for all health care workers in hospital.

INTRODUCTION

Biomedical waste (BMW) is a broader term applied to "any waste that is generated during diagnosis, treatment, or immunization of human beings or animals, or in the research activities pertaining to or in the production or testing of biological which includes ten categories mentioned in Schedule I of the Government of India's "BMW (management and handling) rules 1998"[1].

The average BMW generates in India is estimated to be 1-2 kg/bed/day in tertiary care hospitals and 600 gm/day/bed in a general practitioner clinic. It is estimated that only 5–10% of this comprises of hazardous/infectious waste.[2] According to WHO, 85% of hospital waste is non-hazardous, 10% infective and remaining 5% non-infective but hazardous.[3]

Expansion of health care facilities with the advancement of modern technologies as well as the recent trend of using disposables has led to a high burden of health care related wastes. Improper disposal methods of these wastes may lead to the spread of serious and harmful diseases such as AIDS, hepatitis B and C, and tuberculosis (TB) among the healthcare personnel, waste handlers, patients and the community where the waste is indiscriminately deposited.[4,5,6]

Bio medical waste handling, segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management in any establishment. The scientific study of hospital waste management is necessary as its improper management poses risks to the health care workers, waste handlers, patients, community in general and largely the environment.

The rules framed by the Ministry of Environment and Forests (MOEF), Govt. of India, known as "Bio-medical Waste (Management and Handling) Rules, 1998,"notified on 20th July 1998, provides uniform guidelines and code of practice for the whole nation. India was one of the first countries to implement BMW rules 1998 (amended as draft in 2003, 2011) under Environment Protection Act (EPA), 1986[7].

In order to improve biomedical waste management, it is important to understand and evaluate the current practices to identify the gaps and to address them. Hence the present study is undertaken to evaluate the Biomedical Waste management practices at the levels of source of waste generation, transportation at different patient care areas and to assess the awareness of Knowledge, Attitude and Practices among health care personnel at Vydehi hospital for a period of 12 months.

METHODOLOGY:

The study was conducted at Vydehi Institute of Medical Sciences & Research Centre (VIMS & RC) a 1600 bedded tertiary care center, for a period of 12 months i.e.., from May/2016 to April/2017 after obtaining the ethics committee approval. The data was collected with a preformed checklist of 20 parameters among 4 broad categories of waste management in 40 patient care areas i.e., 5 Emergency areas, 6 ICU, 8 OT's, 16 Wards, 3 Labs, 1 Blood bank & 1 Dialysis unit.

The 4 broad categories of waste management outlined as (i) Condition of waste receptacles i.e. Red, Yellow, Blue waste bins which are lined on inner side by similarly coloured waste bags & punctured proof white waste bins (ii) segregation of waste correctly in such waste bags (iii) Disinfection of waste sharps with 10% sodium hypochlorite solution (iv) Observation at the level of transportation of waste.

It's a direct observational & cross sectional study and simple Random sampling technique was used to select the study subjects for the information regarding waste management

practices. All 40 areas were visited randomly between 7 – 10 AM & 2 – 4 PM on working days, each area observed one time/month only. Thus, a total of 12 visits were made to each area in the span of 12 months period. All observations were made by single person to avoid errors and given"1"mark for desirable & "0" for undesirable observation. There are few parameters, which are in part desirable and in part undesirable is assigned "0.5   mark.

A predesigned semi-structured questionnaire was framed for Doctors, Nurses and Lab technicians and for Class IV Employees it was undertaken verbally to assess the Knowledge, Attitude and Practices of Waste management. The questionnaire was validated and approved by ethics committee.

Table 1 : Check list of parameters for BMW management in each healthcare Area:

BMW Category	No.	Parameter Name
1. Condition of waste receptacles	P1	Is green colored waste bin available in ward?
	P2	Is yellow colored waste bin available in ward?
	P3	Is red colored waste bin available in ward?
	P4	Is blue colored waste bin available in ward?
	P5	Is white container available in ward?
	P6	Has yellow bag placed lining the inner side of the yellow bin?
	P7	Has red bag placed lining the inner side of the red bin?
	P8	Has blue bag placed lining the inner side of the blue bin?
	P9	Are waste bins covered?
	P10	Is the biohazard symbol imprinted over the bags?
	P11	Are posters to guide users displayed near waste bins?
2. Segregation of waste	P12	Does green bag contain only general waste?
	P13	Does yellow bag contain only soiled infected waste?
	P14	Does Red bag contain only contaminated recyclable waste?
	P15	Does white container contain only sharps waste?
3. Disinfection of plastics &sharps	P16	Is disinfectant solution put into white container?
	P17	Is barrel & plunger of syringe separated before immersion into Disinfectant solution?
4.Transportation of wastes	P18	Separate route for transportation of BMW?
	P19	Covered wheeled trolley used for transportation of waste bags?
	P20	Trolley used for transportation of BMW is labeled?

Table 2: BMW management- Knowledge, Attitude & Practices (KAP) questionnaire

No.	KAP Questionnaire response (Yes/ No)
A	Did you heard about BMW?
B	Are you aware of act on BMW rules?
C	Do you know about the Biohazard symbol?
D	Do you know all BMW management categories?
E	Do you know about colour coding segregation of BMW?
F	Do you know whether waste segregation should be done at source of generation?
G	Are you practicing correct method for discarding Human anatomical waste?
H	Are you aware of Health hazards associated with BMW?
I	Will you use personal protective equipment while handling BMW?
J	Are you aware of necessity of Disinfection of BMW?
K	Do you know about the maximum time of BMW allowed to keep in hospital premises?
L	Are you aware of permanent disposal methods of BMW?
M	Does regular educational programs/training being provided for BMW?
N	Do you know about maintaining of BMW records at work place?
O	Had any injuries while handing BMW?

Results:

Table 3. The average mean observations of BMW categories:

Waste categories	Mean	95% CI	
		LL	UL
Condition of waste receptacles (P1- P11)	95.79	93.57	97.64
Segregation waste (P12-P15)	76.48	71.30	81.43
Disinfection of plastics & sharps (P16 & P17)	73.80	67.55	80.47
Transportation of wastes (P18- P20)	52.50	42.50	62.50

The average mean score for BMW management according to Category- wise; Condition of waste receptacles was 95.79%, waste Segregation   was 76.48 %, Disinfection of plastic & sharps was 73.80 % & "Transportation of wastes   was 52.50%.

Highest mean percentage score (Mean = 95.79; CI 93.57-97.64) noted under category of Condition of waste receptacle, lowest mean percentage score (Mean = 52.50; CI 42.50 – 62.50) noted under category of Transportation of wastes.

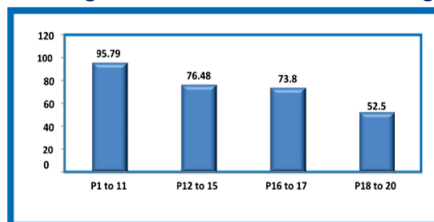**Graph 1. Average mean distribution of waste categories**

Table 4. The Mean distribution of "Condition of waste receptacles" among different hospital areas:-

Area	Condition of waste receptacles					F & P values
	N	Min	Max	Mean	SD	
EMD	5	97.73	100.00	99.55	1.02	F=4.56; P=0.005
ICU	6	90.91	100.00	98.11	3.54	
OT	8	98.11	100.00	99.20	0.80	
WARD	16	68.18	99.62	90.81	8.49	
LAB	3	99.24	100.00	99.75	0.44	
BLOODBANK	1	99.24	99.24	99.24	-	
DIALYSIS	1	100.00	100.00	100.00	-	
Total	40	68.18	100.00	95.79	6.83	

A one way Anova test was performed. The highest mean observed in Lab (M 99.75% with SD 0.44) and lowest was observed in ward (M 90.81% with SD 8.49). Condition of waste receptacles among 40 areas were shown statistically significant. (p=0.005) (Blood bank and Dialysis area were not included for statistics convenience). Posthoc test shows the condition of waste receptacles in wards statistical significance when compared with the mean percentage score in OT, EMD areas.

Table 5. The mean distribution of "Segregation of waste" among different hospital areas:-

Area	Segregation of wastes				F & P values
	N	Min	Max	Mean	SD	

EMD	5	39.58	96.88	67.71	24.01	F= 0.15
ICU	6	62.50	96.88	82.64	11.15	P= 0.35
OT	8	60.42	96.88	77.47	12.52	
WARD	16	39.58	97.92	73.50	18.65	
LAB	3	85.42	96.88	89.93	6.10	
Blood Bank	1	87.50	87.50	87.50	-	
Dialysis	1	71.88	71.88	71.88	-	
Total	40	39.58	97.92	76.48	16.61	

A one way Anova test was performed. The highest mean percentage score is observed in Lab i.e. Mean 89.93 with SD 6.10 and lowest was observed in EMD i.e. Mean was 67.71 with SD 24.01. Means of segregation of wastes among 40 areas of hospital were shown statistically insignificant (p = 0.35). (Blood bank and Dialysis area were not included for statistics convenience).

Table 6. The mean distribution of "Disinfection of plastics and sharps" among different hospital areas:-

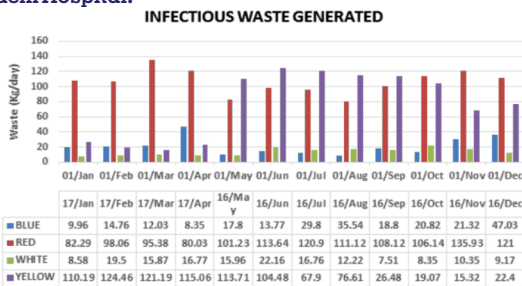| Area	Disinfection of plastics & sharps					F & P values
	N	Min	Max	Mean	SD	
EMD	5	50.00	100.00	76.25	24.01	F=0.36;
ICU	6	47.92	100.00	65.28	20.31	P=0.84
OT	8	27.08	100.00	74.74	25.65	
WARD	16	27.08	100.00	76.69	22.29	
LAB	3	52.08	75.00	67.36	13.23	
Blood Bank	1	100.00	100.00	100.00	-	
Dialysis	1	52.08	52.08	52.08	-	
Total	40	27.08	100.00	73.80	21.88	

A one way Anova test was performed. The highest mean score is observed in wards (M 76.69 with SD22.29) and lowest is observed in ICU (M 65.28 with SD 20.31). The observations of Disinfection of plastics and sharps among 40 areas of hospital were statistically insignificant (p = 0.84).

Table 7. The mean distribution of "Transportation of wastes" among different hospital areas:-

Area	Transportation of wastes					F & P values
	N	Min	Max	Mean	SD	
EMD	5	100.00	100.00	100.00	0.00	F=28.81
ICU	6	66.67	100.00	72.22	13.61	P<0.001
OT	8	66.67	66.67	66.67	0.00	
WARD	16	0.00	66.67	18.75	24.25	
LAB	3	66.67	66.67	66.67	0.00	
Blood Bank	1	66.67	66.67	66.67	-	
Dialysis	1	66.67	66.67	66.67	-	
Total	40	0.00	100.00	52.50	33.66	

A one way Anova test was performed. The highest mean observations noted in EMD (M 100% with SD 0.00) and lowest observed in wards (M 18.75 with SD 24.25). Means of transportation of BMW among 40 areas of hospital are shown statistically significant. (p <0.001). Posthoc test shows the mean percentage score of transportation of wastes in wards showing statistical significant when compared with ICU, OT, EMD, Lab areas.

Table 8. The Total Quantity of Infectious waste Generated at Vydehi Hospital:

INFECTIOUS WASTE GENERATED

	17/Jan	17/Feb	17/Mar	17/Apr	16/May	16/Jun	16/Jul	16/Aug	16/Sep	16/Oct	16/Nov	16/Dec
BLUE	9.96	14.76	12.03	8.35	17.8	13.77	29.8	35.54	18.8	20.82	21.32	47.03
RED	82.29	98.06	95.38	80.03	101.23	113.64	120.9	111.12	108.12	106.14	135.93	121
WHITE	8.58	19.5	15.87	16.77	15.96	22.16	16.76	12.22	7.51	8.35	10.35	9.17
YELLOW	110.19	124.46	121.19	115.06	113.71	104.48	67.9	76.61	26.48	19.07	15.32	22.4

In this study the total observed infectious waste generated in

all categories which shows on an average 217 kg/day & 0.135 kg/bed/day.

**Graph 2: Average infectious waste generated in Kg/month among different categories.**

Average Infectious Waste (Kg/month)
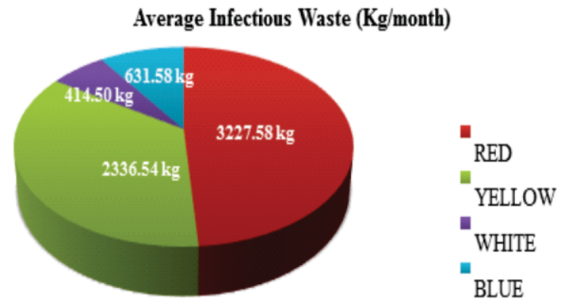
Knowledge, Attitude & Practices (KAP) awareness response among Health Care Workers (HCWs) at Vydehi hospital:

The results showed an average percentage of KAP awareness response of 75.13% among Doctors, 63.2% among Nurses, 54.53% among Lab technicians and 19.28% among Class IV Employees.

Table 9: Knowledge, Attitude and Practices Response among Health Care Workers

Knowledge, Attitude and Practices (KAP) Response among Health Care Workers
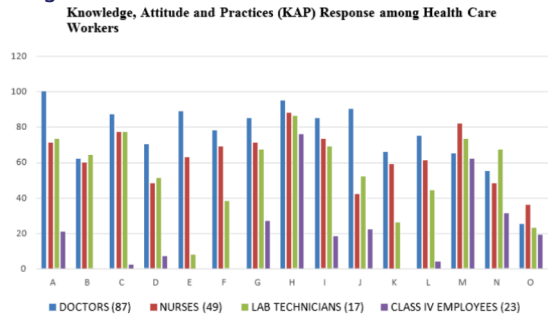
OBSERVATIONS & DISCUSSION :
VIMS & RC generates BMW on an average 217 kg/day & 0.135 kg/bed/day where maximum are contaminated recyclable waste in Red bin. The hospital was following rules accordingly & maintaining colour coded bins appropriately. The Condition of waste receptacles in all the patient care areas of Vydehi hospital were maintained well (M > 99%) especially at Dialysis unit, Blood bank, Labs, OT & EMD (M > 98%). Lower observations (M = 90.8 %) noted at wards due to lack of Knowledge Attitude Practices awareness about BMW management. Various studies have found poor "condition of waste receptacles" for waste disposal. In a 600-bedded super-specialty corporate hospital of a South Indian city, there were only white receptacles for all types of BMW for aesthetic reasons and since the colour of all receptacles or bins was same, following the segregation practices was difficult[8]. Studies in Irbid city of Jordan[9] and UK[10] showed, waste bins or receptacles were found to be in poor shape.

Segregation of waste is the most crucial aspect of BMW management, more focus need to be laid in certain areas of hospital particularly in EMD (M= 67.7%)&well maintained in L a b & ICUs (M > 82%) may be due to relatively good staff to patient ratio whereas overcrowding of patients in EMD and relatively less staff to patient ratio may be the cause for relatively lower score in EMD, the lag mainly seen with Red bin where only recyclable waste was not maintained (M= 66.4%). In a study in 1100 bedded hospital attached to a tertiary care public hospital in North India, it was found that waste segregation has high score (mean: 96%)[11]. In a study of 1800- bedded tertiary care hospital in Mumbai[12], it was found the waste segregation was less than satisfactory in 40.3% of areas in spite of continuous monitoring and informal counselling of HCWs. Studies

conducted in Egypt[13]and Ethiopia[14], the waste segregation practices were found to be poor. In a study conducted at a 350-bedded polyclinic at Luck-now, India[15]and 574-bedded tertiary care Medical Institute located at Belgaum, Karnataka, India[16], the waste segregation practices were found to be good. However, the authors did not mention the exact percentage of areas where segregation practices were found good.

In this study, relatively lower score (mean: 73.8%) of category - Disinfection of plastics & sharps   as compared to other categories of waste management indicates that this aspect of waste management is generally overlooked by HCWs. Amongst the various areas, the significantly low scores observed in Labs ,ICU and Wards due to inadequate supply of disinfectant solution (Sodium Hypochlorite [Naocl]) and lack of awareness among concerned health care personnel. Various studies have mentioned that HCWs were using chlorine solution[17]or autoclave to disinfect the waste; however, the authors have not mentioned the extent of compliance by HCWs.

Amongst all categories, lowest score has been observed for the "Transportation of waste" category as compared to other categories of waste management in all hospital patient care areas (mean: 52.50%), significant low score is observed in wards (mean: 18.75%) as there is no separate route for transportation of BMW.

Analysis of infectious waste generated at Vydehi hospital:

The main objectives of BMW management is mainly to reduce waste generation, to ensure its efficient collection, handling, as well as safe disposal in such a way that it controls infection and improves safety for employees working in the system. It is estimated that annually about 0.33 million tons of hospital waste is generated in India and, the waste generation rate ranges from 0.5 to 2.0 kg per bed per day[18].

In this study mean infectious waste generated per bed per day is 0.135kg. This is much lesser than seeing in study carried out by Srivastava S in a 650 bedded government medical college, Jhansi where the waste generated was 0.5 kg/bed/day[19].

The average infectious waste generated at Vydehi hospital per day is 217 kg. This is lower than the study carried out by Anita et al. over a period of 5 months in 850 bedded Chhatrapati Sivaji Subharti Hospital; Meerut which showed 289.56 kg per day[20]. Waste generated at Vydehi hospital is comparatively less due to small amount and judicious use of disposables as our hospital is catering to more rural patients.

Knowledge, Attitude and Practices of Health care Professional at Vydehi Hospital:-

The study showed that out of 176 health care professionals Doctors (75.13%) had better knowledge regarding BMW management, that correlates with the findings of a study conducted at Dhaka, Bangladesh, where doctors (37%) had more knowledge than other cleaning staffs[21].

All the participants have heard about BMW management. It is similar to studies carried by Chudasama et al [22] in a tertiary care hospital in Rajkot and Madhavi et al. in Khammam [23] who found 95.4% and 94.8% of the participants were aware of BMW, respectively.

Class IV Employees were not aware of act on BMW rules, about colour coding segregation of BMW, waste segregation done at source of generation, about the maximum time of BMW allowed to keep in hospital premises. The reason for lack of awareness is due to their poor literacy rate, lack of adequate training, lack of motivation and negligence.

CONCLUSION:

1. Though the BMW management at Vydehi hospital is better than other hospitals in state, since it is an NABH Accredited hospital, following standards and defined norms still more scientific basis needs to be laided for Segregation of waste, Transportation of BMW, Disinfection of plastics &sharps especially in Wards.

2. Condition of waste receptacles in all patient care areas for proper segregation of waste at the source of generation is well placed at Vydehi hospital. The Segregation of waste is crucial aspect of waste management is not appropriately addressed which was least maintained in Emergency Medicine Department due to overcrowding of patients and relatively less staff to patient ratio in EMD. Proper disinfection of wastes & sharps should follow strictly to prevent biomedical hazards. Day to day collection of waste was done, but there is no separate route for transportation at wards.

3. It is concluded that the Knowledge, Attitude and Practices awareness response is better among Doctors, followed by Nurses and Lab technicians when compared to Class IV employees at Vydehi hospital.

4. While there were some good practices observed like condition of waste receptacle, biohazard symbols imprinted over bags etc. along with the awareness regarding BMW Management seen among many of the staff included in the study. However, there were deficiencies seen in the practices observed. Continuous medical education is an important means to improve knowledge in health care professionals.

Recommendations:

The below mentioned recommendations were made to improve waste management practices in the hospital.

1. Government guidelines modified from time to time has to be included in the latest version and need to be circulated and to be discussed in departmental meetings.

2. Segregation of Biomedical waste as per color coding, its weighing at the generating site and transportation in closed trolleys is required to be ensured.

3. To ensure proper disinfection of plastic and sharps, providing adequate supplies of disinfectant solution in all wards and ICU needs to be enhanced.

4. Colored posters showing the segregation of BMW in order to guide the users and should be displayed in all areas in the local language mainly for spreading awareness to Class IV employees.

5. Each patient care area should be provided with the waste receipt book to record the quantity/number of yellow, blue, red, white (translucent) bags handed over to HCW.

6. All the biomedical wastes should be labeled as waste type, site of generation, date of generation before transportation from the generation site.

7. All attempts should be made to provide separate service corridors for taking waste from the storage area to the collection room. Preferably these corridors should not cross the paths used by patients and visitors.

8. To ensure occupational safety of all health care workers and others involved in handling of biomedical waste - appropriate and adequate personal protective equipment should be made available.

9. Sensitization of all categories of staff regarding health hazards/risks from biomedical waste is required urgently and their regular training on IMEP at least once in a year must be ensured.

10. To conduct the health check up at the time of induction, provide training to all the health care workers and immunize all health workers at the time of induction and thereafter at least once in a year.

11. Regular monitoring committee has to be constituted at various levels to ensure BMW management process is adhering to given guidelines.

12. An important challenge to be overcome is the need to progress from the concept of "waste management" to one

of sustainable decision making regarding resource use, including methods of waste minimization at source and recycling. It is therefore strongly recommended that waste management programs should be a part of academic curricula for all health care workers and in continuing medical education.

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