Bio Medical Waste Generation and Management Practices in V.S.S. Medical College & Hospital, Burla, Odisha, India

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Abstract Background: An important issue of environmental protection process is the solid waste management that includes responsible planning of collecting, transporting, processing and disposing of hazardous and non-hazardous solid waste material. The health of public, patients and professionals alike are affected by poor waste management practices. The study highlights a holistic approach of biomedical waste management with regards to the chain of environmental and health risks and concerns aimed in achieving the fundamental premises for a systemic approach of biomedical waste management. An attempt has been made to critically review the current management practices adopted in V.S.S. Medical college & Hospital. Following the Rules and Regulation the methods for segregation, packaging, labeling and the treatment techniques for reduction in volume, neutralization and final disposal of the biomedical waste are analysed. Methods: Personal observations of the waste treatment and disposal practices and Assessment of knowledge, attitude and practices of working personnel with the help of questionnaires were followed in this study. The information obtained has been confirmed by means of direct spot visit. The views and suggestions of working personnel over existing conditions/methods of biomedical waste management in the hospitals were also recorded. The information obtained was later confirmed by means of direct observations. Results: There are 20 units having total bed capacity of 1006. The daily generation of category 1 & 2 is 40-50 kg/day. The daily generation of category 3 waste is 2-3 kg which was measured one day after one day. Category 4&5 waste generation amounting 30-40 Kg/ day. The Solid waste, (category 6) generation amounting 80-90kg/ day. The solid waste, category 7 waste generation is 30-40 kg/ day. Waste generated from laboratory (category,8) was estimated and found to be 30-40 litres/ day and the incineration ash category 9 generation was recorded as 3-4 Kg/ day. The chemical waste category 10 was not properly assessed by the CBWTF. The current segregation practice is not that efficient in reducing the waste going to incinerator. According to the opinion of employees at V.S.S. Medical College and hospital burla, the important reasons for the improper segregation of wastes are; inappropriate location of waste bins, waste bins

being full and lack of knowledge regarding the constituents of medical waste. Conclusion: The performance of CBWTF can be enhanced with cooperative efforts of BMW generators possible if a healthy co-ordination exists between CBWTF and BMW generators.

Keywords CBWTF, Biomedical Waste, Incinerator, Shredder, Microwave

1. Background

Many strides have been made in the field of health care system over the years. Ironically, along with restoring and maintaining community health, health care settings also threatened their well-being. The health of public, patients and professionals alike are affected by poor waste management practices [1]. In addition to this, it also contributes to environmental degradation. In 1983, a meeting was held at Bergen, Norway. The meeting was convened by the World Health Organization (WHO) regional office for Europe. The Biomedical waste management issue was first discussed during this meeting. Now, years later, this has turned into a global humanitarian issue.

Current Waste Management practices are characterized by poor quality collection service and improper disposal at open dumpsites. Hospital, hazardous and household wastes are mixed together at site. Recoverable wastes, paper and glass are destroyed than separated and recycled for economic use.

Uncontrolled burning of medical wastes may pollute the air with acidic gases, dioxins, furans and heavy metals [2]. A clear relationship between the burning of chlorinated organic chemical products and wastes, especially PVC and dioxin emissions from combustion facilities was reported by a host of studies conducted at the University of Florida [3,4,5,6,7,8]. A number of common initiatives to manage health care waste are reported from developed countries. Most of the western nations had common incinerators, which are now banned in some of the developed countries. The shifting from burning to non-burning technology is being undertaken in a phased manner [9]. Paul Carnet reported that a number centralized

treatment and disposal facilities for hospital wastes existing in USA in Canada. The technology used in combination of incineration and landfill.

Incineration utilizes thermal energy to decline waste materials to non-combustible residue or ash and exhaust gases [10]. The Fly and bottom residues produced after medical waste incineration contain high level of heavy metal like Pb, Cd, Ni, Cr, Cu and Zn. However, despite of public concerns about incinerators, it is the most frequently used option, due to its advantages regarding the sterilization of pathological and anatomic waste, volume and mass reduction, and energy recovery [11]. Autoclaving/sterilization is the second most commonly used waste disposal technology. The process involves steaming the waste materials at lethal temperatures to penetrate and potentially kill pathogens[12]. Autoclave is viewed as a more costly method than incineration [13]. One of the major disadvantages of autoclave pointed out is that it doesn't reduce the size of waste fed in to the system. The treated waste then has to go to the landfill sites which again cause many environmental threats. Many studies shows that a shredder incorporated with an autoclave can be the best option to treat the medical waste [12].

The microwave process utilizes the radiant energy to kill infectious agents by converting radiant energy to heat and pressure. Shredding is usually combined with microwave technology. A combined on site Microwave - small scale incinerator technology is the most cost effective and environmental friendly treatment technology [14]. The disinfection efficiency of microwave can be a performance issue for microwave [15]. In chemical treatments, chemicals like chlorine, formaldehyde, ethylene oxide etcetera are used as disinfectants. Again the effectiveness of disinfection is questioned as it is dependent on the temperature, pH and surface area [15]. None of the alternative technologies are totally risk free, they can be combined with an effective program of waste reduction and segregation to reduce the environmental impacts and financial cost of medical waste disposal. The criteria's used to evaluate technological option should consider environmental, health and economic factors [16]. The best technology for the medical waste treatment will be different for different hospitals. It may depend on the local conditions and the requirement of the hospital.

For selecting the most efficient treatment method of hospital wastes, the composition analysis is considered to be the fundamental information. Currently there is no information done regarding the characteristics biomedical waste generated in V.S.S. Medical College and Hospital. With the above background the present study was carried out to assess the quantum of biomedical waste generation as well as the present state of management practices in the hospital.

2. Materials and Methods

Personal observations of the waste treatment and disposal practices [17,18,19] and Assessment of knowledge, attitude and practices of working personnel with the help of

questionnaires were followed in this study [20,21,22,23,24,25]. A questionnaire was prepared that included questions regarding number of inpatients/day, outpatients/day, number of beds (total), awareness about biomedical waste (management and handling) rules, 1998, categories of biomedical waste produced and estimated quantity (kg/day), waste segregation, collection, labeling, transport and disposal, financial and personal resources. The information obtained has been confirmed by means of direct spot visit. The views and suggestions of working personnel over existing conditions/methods of biomedical waste management in the hospitals were also recorded. The information obtained was later confirmed by means of direct observations.

3. Results

Table1. The number of facilities and beds available in V.S.S. Medical College Burla.

Sl. No.	Name of the Department	No. of Beds
1	Medicine	180
2	Surgery	180
3	Paediatrics	90
4	Orthopaedics	30
5	Pulmonary Medicine	50
6	Skin and VD	36
7	Ophthalmology	60
8	E. N.T.	38
9	Radiotherapy	24
10	Cardiology	20
11	Psychiatry	20
12	Neurology	20
13	Dental	02
14	Urology	20
15	Nephrology	20
16	Infectious Ward	04
17	Neurosurgery	20
18	Obestic & Gynecology	150 (including PPC 10)
19	Paying Cabin	18
20	SNCU Unit	24
	Total	1006

In the endeavour undertaken by the CBWTF, different category of waste coming to central biomedical waste management facility (CBWTF) the daily generation of category 1 & 2 is 40-50 kg/day. The daily generation of category 3 waste is 2-3 kg which was measured one day after one day. Category 4&5 waste generation amounting 30-40 Kg/ day. The Solid waste, (category 6) generation amounting 80-90kg/ day. The solid waste, category 7 waste generation is 30-40 kg/ day. Waste generated from laboratory (category,8) was estimated and found to be 30-40 litres/ day and the incineration ash category 9 generation was recorded as 3-4 Kg/ day with a bed capacity of 1006 having 20 different units. Number of beds in different treatment units has been depicted in Table 1. Whereas, the chemical waste category 10 was not properly assessed by the CBWTF.

The Central Biomedical Waste Management Unit of V.S.S. Medical College Burla collect the biomedical waste generated daily from each unit quantify and maintained the record in a prescribed format. (Table 2a & b). From the record it was observed that the CBWTF collect the waste in three different colour coded bags i.e. Yellow, Red and Black.

Simultaneously, the sharp wastes are collected in punctured proof carry bags. During the investigation it was found that on an average the hospital including all the units itself generated 8 kg/day of waste collected in Yellow bag, 58.3 kg/day in Red bags, 132.5 kg /day in Black bags and 53.7 kg /day in ppc.

Table2a. Waste generated at different units per day at V.S.S. Medical College Burla.

Generating Points/Hospital wards	No. of Bags			Wt. in KG				Occupancy	Segregated/M utilized	Handed over to BMW	Signature
	Y	R	B	Y	R	B	PPC				
MMW I/II/III/IV		3	3		1.44	4.22	00	x	x	x	x
Neurology-M/V/VI								x	x	x	x
FMW-Neurology-F		2	1		1.5	16	8.0	x	x	x	x
Cardiology-F					0	0	0	x	x	x	x
Nephrology-F					0	0	0	x	x	x	x
Cardiology-M & ICU		2	2		0.1	2.0	3.0	x	x	x	x
Nephrology-Male& Dialysis		5	5		0.5	1	0.2	x	x	x	x
Male Surgical I/II/III/IV		6	3		5	8	5	x	x	x	x
Female Surgical		2	1		1.0	2.0	1.0	x	x	x	x
Surgery-Main O.T.	1	2	2		1.0	1.5	0.1	x	x	x	x
Emergency O.T	1	2	2					x	x	x	x
Burn Unit	1	1	1		1.5	2.5		x	x	x	x
Orthopedics -Male		2	1		2.0	1.5	1.0	x	x	x	x
Female		2	1		1.0	2.0	0.1	x	x	x	x
O.T.	1	2	2		1.7	1.1	2.0	x	x	x	x
S.N.C.U		2	2		0.4	2	1.0	x	x	x	x
Plastic Surgery	1	1	1		0.3	-	-	x	x	x	x
Neurosurgery-M&F		1	1		0.1	0.2		x	x	x	x
O.T.	1	1	1					x	x	x	x
Urology-M & F		1	1		1.5	1.5	1.0	x	x	x	x
O.T.	1	1	1		2.0	3.0	0.1	x	x	x	x
I.C.U.		1	2		0.2	1.2	1.0	x	x	x	x
Eye-OPD		1	1		0.5			x	x	x	x
O.T.	1	1	1					x	x	x	x
Male& Female ward		2	2		0.1	0.4	03	x	x	x	x
ENT-O.P.D.		1	1		0.3	0.3		x	x	x	x
O.T.	1	1	1		1.2	0.6		x	x	x	x
Male & Female ward		2	2		1.0	2.0	0.5	x	x	x	x
O & G-Ward		6	3		2.5	8.0	1.5	x	x	x	x
Labour room	5	8	2	7	15.0	20.0	2.0	x	x	x	x
PP Centre		1	1		0.1	0.1		x	x	x	x
O.P. D.		1	1		0.1	0.2		x	x	x	x
O.T.	2	5	1	1	3.0	0.3	0.5	x	x	x	x
Dental OPD	1	1	1		0.5	0.5		x	x	x	x
Medicine OPD		1	1		0.2	1.0	0.5	x	x	x	x
SPM OPD		1	1		0.5	0.5		x	x	x	x
T.B. Chest O.P. D		2	1		1	0	0	x	x	x	x

Y= Yellow, B= Black, R= Red, PPC= puncture proof container

Table 2b

Generating Points/Hospital wards	No. of Bags			Wt. in KG				Occupancy	Segregated/ Mutilated	Handed over to BMW	Signature
	Y	R	B	Y	R	B	PPC				
Dressing Room		2	1		1.0	0.7		x	x	x	x
RDC		5	5		1	2.7	2.9	x	x	x	x
Blood Bank		6	4		2.9	7.6		x	x	x	x
Casualty & emergency O.T.	3	6	4		5.0	3.0	2.0	x	x	x	x
Ortho OPD		1	1		0.5			x	x	x	x
Sickelcell Unit		1	1		0.2	0.1		x	x	x	x
								x	x	x	x
Total				8	58.3	132.5	53.7	x	x	x	x

Y= Yellow, B= Black, R= Red, PPC= puncture proof container

Table 3. Waste generated at various health care centre of Sambalpur and Burla transported to BWTF, V.S.S. Medical college Burla per day

Name of Hospital: Private Health Units of Sambalpur & Burla	Wt. in Kg		
	PPC	Y	R
Janani Maternity, Modipara	1	4.7	1.9
Sanjivani Hospital, Modipara	0.5	3	1
Jalan Nurshinh Home, Khetrajpur	0.5	2.5	1
Sumitra Nurshing Home, Khetrajpur	0.7	2.7	1
Astha Nurshing Home, Budha Raja	0.5	4.7	1.9
Jyoti, Hopital Budharaja	0.2	3	1
Srusti Nurshing Home, Budharaja	1	3.5	1.5
Balaji Nurshing Home, Hospital road, SBP	0.5	2	1
Ashirwad Nurshing Home, Hospital road, SBP	1	1	1.2
Lifeline Diagnostic, Hospital road, SBP	0.5	2.7	1
Basundhara Maternity, dhobipada, SBP	0.4	3	1
Hariom Nurshing Home, Budharaja	0.3	3	1
JMJ Hospital, NH Baraipali	0.2	2	1.5
Amrita Health care, Majhipali, SBP	0.2	4	1
Pratima Nurshing Home, NH Baraipali	1	2	1.3
Seva Nurshing Home, Sakhipada, SBP	0.3	3	1
Patel Nurshing Home, Burla	1	2.9	1.3
Binayak Nurshing Home, Burla	0.5	1.5	1.5
Ramachandi Nurshing Home, Burla	2.5	1.4	0.9
Gupta Nurshing Home, Burla	1	4.7	1.9
Samleswari Nurshing Home, Burla	2.8	1.5	1.9
Gupta Diagnostic centre, Burla	1.9	1.2	0.9
GouriShankar Nurshing Home, Burla	0.5	3.7	1.9
Sparsh Nurshing Home, Sambalpur	0.4	1.2	1.5
Rohini Diagnostic centre, Burla	2.7	2.5	1.3
Sree Nurshing Home, Kamli Bazar, SBP	0.5	1.5	1
Trilochan Netralaya, SBP	0.2	3	2.2
Chakshusyam Eye clinic, Burla	0.1	2.5	1
Samarpan Children Hospital, Sambalpur	1	1.9	1
A. K. Clinic, Burla	0.4	1.5	1.5
Nidan, Nurshing Home Burla	1	2.5	1.5
Total Per day BMW generated	25.3	80.3	32.8
Per year generation	9234.5	29309.5	11972

Further, the wastes generated in different health care centre of Sambalpur town which is 18 Km away from the CBWTF are collected and transported to CBWTF for treatment and disposal. There are 31 health care centres at Sambalpur locality. All the health care centres transported the waste in three different colour coded bags i.e. ppc, yellow and red. From the analysis it was found that the total per day waste transported to CBWTF was 25.3 kg, 80.3 kg and 32.8 kg/ day in PPC, yellow and red bags respectively (Table.3)

To find the greenhouse gas emissions from the transportation of medical waste 2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting [26] is used. The estimated distance covered by the vehicle used for transportation of biomedical waste from different government and private health care unit located in and around Sambalpur and Burla town to the CBWTF at V.S.S. Medical College is 50 KM/day

Total distance travelled by truck in a single day = 50 kms $\times$ 2 (no. of vehicles) = 100 Kms

Consumption of fuel = 20 litres of diesel per day = 20 $\times$ 365 = 7300 litres per year.

The total emissions was found to be 23,204.51kg. The calculation of GHG emissions using emission factors is explained in Table 4.

Table 4. Total GHG emissions during BMW management

Types of emission	Conversion Factor (CF)	Units of diesel (litres)	Resulting emissions in Kg CO ₂ eq = CF x Units
Direct emissions			
CO ₂	2.6413	7300	19281.49
CH ₄	0.0015	7300	10.95
N ₂ O	0.0292	7300	213.16
Indirect emissions	0.5067	7300	3698.91
TOTAL EMISSIONS			23,204.51

Waste Management Practices in V.S.S. Medical College Burla

The plastic bins as per the norms are kept in each facilities and the waste are collected and transferred to the Biomedical Waste Management Facility. The wastes were segregated into various categories of waste like incinerable waste and recyclable waste depending upon its composition and properties. The plastics and other glass wares were however recycled immediately and were not stored anywhere as in case of other biomedical waste stored in bins. The waste so generated is stored in drums for a period of 10-15 days and then it is treated after a bulk in heaped. Three separate devices has been installed and used for BMW management.(a)Incinerator(b) Microwave and (c) Shredder.

The capacity of the Incinerator is 70 Kg/ hr and the height of the chimney is 100 ft. through which the gases exhaust to the atmosphere. (Table. 5). There is a facility for cooling and the waste water generated during the process is released

directly to the drain. The running time of the incinerator is between 8.30 AM – 1.30 PM depends upon the amount of waste collected. Mostly the anatomical and solid based waste has been treated in incinerator. The ashes generated by the process are dumped in sanitary landfill. The microwave installed in the CBWTF has the capacity of 100 Kg/hr. the solid based waste has been treated through microwave to disinfectant the waste and after that the waste has been send for auction. Similarly, the shredder installed in BMW unit of V.S.S Medical has the capacity of 100 Kg/hr. The shredder has been used for cutting the plastics. After disinfectant by microwave the plastics were send for auction for recycle.

Table 5. the operating and emission details of the incinerator

Parameters	Existing in CBWTF	Permissible limits
<u>Incineration standards</u>		
Combustion efficiency	90%	99.0%
temperature of the primary chamber	850°C	800 $\pm$ 50°C
Temperature of the Secondary Chamber	1050°C	1050 $\pm$ 50°C
<u>emission standards</u>		<u>Concentration mg/Nm³ @ (12% CO₂ correction)</u>
1. Particulate matter		150
2. Nitrogen Oxides		450
3. HCL		50
Minimum stack height	100m	30m above ground

4. Discussion

There are no reliable data available of the quantum of waste generated per person per day either in indoors or out door patient in Indian Hospital particularly in Odisha. Even there is no uniformity in the data on the quantum of biomedical waste being generated. From the data available from Armed Forces Medical College where the average daily waste generated of anatomical waste is 5.6 kg, Animal tissue waste 7.1 kg, Micro and Biotechnological waste 5 kg, Discarded medicines and cytotoxic drugs nil, waste soiled 9.5 kg, solid waste 149 kg, liquid waste 73 litres, incinerator ash nil, chemical waste 7.1 kg, waste sharps not assessed [27]. In the present study the average daily waste particularly the anatomical waste shows high quantity i.e. 40-50kg/day, the waste sharps generation shows 30-40kg/day. The variation in the quantum of waste generation differs not only from country to country but also within the country which depends on the type of health care establishment, hospital specialization, proportion of reusable items employed in the health care centres and proportion of patients treated on a day-care basis.

According to WHO, the hazardous waste in an hospital is around 10-25% of the total health care waste. This study shows that the medical waste generated at V.S.S. Medical College is 49 % of the total health care waste produced in the hospital, which clearly states that the current segregation practice is not that efficient in reducing the waste going to

incinerator. According to the opinion of employees at V.S.S. Medical College and hospital Burla, the important reasons for the improper segregation of wastes are; inappropriate location of waste bins, waste bins being full and lack of knowledge regarding the constituents of medical waste. Thus the study shows that the waste management activities at the V.S.S. Medical College and hospital have to be improved.

The knowledge about the constituents of medical reason is generally considered as one of the main barrier towards proper medical waste management [28]. But the study shows that the health care workers at V.S.S. Medical College and hospital seemed to be aware about the constituents and the hazardous nature of medical waste. This may be because of the familiarity of health care workers with syringes and needles and also with accidents that happen as a result of sharps injury [29,30]. Some confusion does exist among workers especially about chemicals, unused medicines and pressurized containers. These confusions can be avoided by proper training. But these wastes account for only a small amount of the medical waste and cannot be assumed as the reason behind higher generation of hazardous waste. One of the reasons behind inefficiencies in the sustainable waste management practices are related to the behavior of individuals [31]. Considering the fact that most of the workers have enough knowledge about the constituents of medical waste and employees being satisfied with the current waste management practices, it can be interpreted from the study that there is a value – action gap between their intended behaviour and actual practice towards waste management. Lack of incentives, awareness of recycling provision and apathy have crucial role in framing such behaviour [32]. Appropriate facilities, opportunities to put right waste in the right bin, convenience, time and space are some of the factors affecting this behaviour [33,34].

Various studies shows that due to the high capital and maintenance cost involved, developed countries are bringing an end to the incinerators and are investing more on the alternative treatment technologies impact [35,36,37,38,39,40]. Well the argument is true for municipal waste, but for medical waste when considered from the hospitals perspective, incineration seems to be a better option from the available technological alternatives.

As V.S.S. Medical college is a very big hospital with almost every health care facilities it was important that the on site treatment plant selected should treat all the types of waste. Incinerator is not a very bad idea if the future energy requirements and the potential long-term health effects are considered along with the environmental impacts [41]. If properly handled and proper segregations are done, incineration would be the suitable method to treat clinical waste [13,1]. There has been an increase in public concern about the medical waste management over the years [1]. There has been a wide protest against the incineration plants around the globe [42,43].

5. Conclusions

The study presents the status of existing CBWTF at V.S.S. medical college & Hospital, Burla Odisha, India. An appropriate strategy for safe management of BMW has been taken up integrating technical, financial, institutional, managerial, social and environmental issues. The technology used in CBWTF is a combination of incineration, microwave, shredder and secured landfill. The unit started operation in 2006. All the BMW generators are yet to get enrolled to utilize this off-site facility. The facility has to face problems while burning BMW, as many BMW generators do not adhere to the rules of segregation in to the container bags at the point of generation and are not labeled according to Schedule III of BMW (Management and Handling) Rules, 1998. The performance of CBWTF can be enhanced with cooperative efforts of BMW generators possible if a healthy co-ordination exists between CBWTF and BMW generators.

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