

Summary and Conclusion of biomedical waste research work

Work done by the Research Scholars

The primary goal of the study is to assess (i) Biomedical waste (BMW) generation rate (ii) Number of Health Care Facilities (HCFs) and beds in HCFs (iii) Number of Common Biomedical Waste Treatment Facilities (CBMWTFs) and management practices in India as well as in Andhra Pradesh State. The results obtained from the secondary data of India and Andhra Pradesh was linked to check the precision of BMW generation and management practices in Chittoor District of Andhra Pradesh based on primary data collected through questionnaires. The present study is helpful for HCFs as well as for Pollution Control Board authorities, India, to take appropriate remedial steps for proper BMW management in India

In the present study, Chapter – I describes about the existing HCFs and their bed strength in India. It also examines the outsourcing BMW treatment facilities namely CBMWTFs. Based on the data collected for entire India, BMW generation rate has been assessed and also the amount of BMW that was being treated and untreated has been evaluated.

Chapter – II deals with number of public and private HCFs available, their bed strength and waste generation in entire Andhra Pradesh. A case study was taken up on CBMWTF located at Pacchikapalam, Chittoor District to examine whether the infrastructure available in CBMWTF is sufficient to treat the amount of BMW generated in both public and private HCFs of Chittoor District. An attempt was also made to see the feasibility and viability of establishing in-house BMW treatment facility for each individual HCF having more than 200 bed capacity.

The main study focuses on Waste Management Practices and original BMW generation rate, segregation practices, treatment technologies etc., were studied and described in Chapter – iii. The results were evaluated and linked to the National BMW generation rate and discussed in the present chapter. The summary and conclusions were given in this chapter under each hypothesis which were postulated to examine the BMW

segregation methods, treatment and disposal practices employed in each HCF, waste handling safety measures and BMW administration in Chittoor District.

Due to limitations of the present study, the work has been confined to Chittoor District of Andhra Pradesh, India. For an assessment of situation within the health care establishments of India as well as cities/towns as a whole is necessary before making any policy decision or attempts for improvement of BMW segregation and management practices. This essentially creates an avenue for future research and this involves survey of waste generation, documentation of prevailing practices, and allocation of responsibilities, creating awareness and providing training programmes to the waste management human resources.

Summary – India Data

The first objective of the study is to *cognise at the macro level in India the occurrence of Bio Medical Waste and the trends in the industry*. From the data, it is evident that average waste generation in India is 0.285, 0.287 and 0.309 kgs/bed/day for four continuous years. Lowest and highest Bio Medical Waste generation rates for all the three years were examined.

South India (SI)

In South India, the lowest BMW generation (0.11 kgs/bed/day) rate was found in Andhra Pradesh State and the highest (0.56 kgs/bed/day) was found in Karnataka State. The average bed strength per HCF is 28.55 and average BMW generated is 1.04 kgs/bed/day.

North India (NI)

BMW generation (0.13 kgs/bed/day) rate was found to be the lowest in Himachal Pradesh State and highest (0.48 kgs/bed/day) in Uttar Pradesh State in North India. The average bed strength per HCF is 13.9 and average BMW generated is 0.29 kgs/bed/day.

East India (EI)

In East India, BMW generation (0.1 kgs/bed/day) rate was low in Meghalaya and high (0.32 kgs/bed/day) in West Bengal State. The average bed strength per HCF is 16.8 and average BMW generated is 0.52 kgs/bed/day.

Western India (WI)

The lowest BMW generation rate (0.1 kgs/bed/day) was found in Daman and Diu of Western India and Goa state was found to be the highest BMW producer (1.12 kgs/bed/day). The average bed strength per HCF is 8.8 and average BMW generated is 0.412 kgs/bed/day.

Central India (CI)

The lowest (0.3 kgs/bed/day) rate was found in Chattisgarh and the highest (1.17 kgs/bed/day) was observed in Madhya Pradesh State of Central India. The average bed strength per HCF is 21.65 and average BMW generated is 0.22 kgs/bed/day.

Based on the data, it is clear that there is increasing trend in BMW generation over year to year. But the number of facilities to treat BMW is not sufficient. In all regions the untreated waste was also noticed in large amounts.

Andhra Pradesh State Data

The second objective of the study is *to account for the Bio Medical Waste generation in the State of Andhra Pradesh and the management practices in vogue.*

The data on number of private specialized HCFs and their bed strength in entire Andhra Pradesh State aid to know the distribution of beds among different categories of Private HCFS. Greater Hyderabad was brooding the highest number of HCFs with 28.02 percent bed strength. Among all the HCFs of Greater Hyderabad, 86.9 percent beds were from General Category followed by Pediatrics (5.4 percent) and Surgery (3.5 percent) HCFs East Godavari District stands second highest place with 9.19 percent bed strength followed by Krishna District with 7.54 percent of bed strength. The lowest percentage of bed strength was found in Adilabad district with 0.89 percent. Among all specialized HCFs in Adilabad district, 46.9 percent were from General Category followed by Surgery with 34.1 percent and Orthopedics with 7.7 percent. Majority of Private specialized HCFs were centralized in either cities or urban localities, where population was high. It seems all HCFs were established based on the population. Hence the present study found that more number of beds in Private HCFs was identified in Greater Hyderabad followed by East Godavari and Krishna District. The highest number of Government HCFs was also identified in Greater

Hyderabad followed by Visakhapatnam, Guntur and Chittoor. This also seemed to be distributed based on the population.

BMW generation was also high in Greater Hyderabad followed by Visakhapatnam whereas the lowest amount of BMW generation was observed in Cuddapah district followed by Nizamabad, Karimnagar and Warangal Districts. Same trend was also identified in BMW generation from each bed/day. Average BMW that was being generated per bed per day was derived from the State data (data from APPCB, Hyderabad) and found that it was 0.11 kg/bed/day. Based on this, it can be inferred that from 3,834 Private HCFs with 72,745 beds, 8001.95 kgs/day of BMW is generated from the entire Andhra Pradesh. Similarly, 392 Government HCFs with 61,200 beds were generating 6,732 kgs/day of BMW in Andhra Pradesh. The total amount of BMW generated from Private and Government HCFs of Andhra Pradesh State is 14,733.95 kgs/day. As per the survey data, majority HCFs responded that 0.4 kgs/bed/day of BMW is generated. If this amount of BMW is implied to know the exact waste generation in Andhra Pradesh, then it would be 53578 kgs/day.

However the Government has established outsourcing facility called CBMWTFs to treat BMW. As per the APPCB data for the year 2011-2012, there were 5,449 HCFs with 95,327 beds were registered for outsourcing. As a result, 13,018 kgs/day BMW was being treated in CBMWTFs (Sarojini et al., 2007). Therefore, it is evident that $(53578 - 13,018)$ 7,124.42 kgs/day of BMW waste was left untreated and there was no information on the management of untreated waste either from HCFs or from the Government. This is an alarming situation for environment and this needs immediate attention for proper environmental management to safeguard the biotic and human health.

As per the study, in Chittoor District there were 9,839 beds present. If this was calculated with the average BMW generated (0.11 kg), the amount of BMW generated per day is 1,082.29 kg/day. As per the survey data, BMW generation in majority of HCFs is 0.4 kgs/bed/day. If this is treated as an average BMW generation, then the BMW generation in Chittoor District is $(9,839 \times 0.4)$ 3935.6 kgs/day.

Therefore, it is identified that 2853.31 kgs/day BMW is left untreated in Chittoor District.

To identify and evaluate the feasibility of establishing in-house treatment facilities, cost comparison between CBMWTF and estimated in-house treatment facilities were made. The cost analysis of outsourcing versus in-house facility revealed that, a HCF having more than 200 bed capacity can save Rs. 2.31/ kg at in-house facility. Besides, it can generate revenue by treating BMW from others HCFs as .

Survey Data – Chittoor District

The survey has been conducted in Chittoor District to thoroughly examine the nature and the quantum of Bio Medical Waste Generated at district level in the district of Chittoor in A.P.; to evaluate the techniques and management practices involved in the process of Bio Medical Waste movement in the District; to highlight the problems faced in Bio Medical Waste Management in District and to render policy implications for better Bio Medical Waste Management in the wellbeing of the institutions, environment and society.

In the present study two types of HCFs were taken into consideration, they are Private and Government HCFs. Based on the type of hospital, research hypothesis was framed to test the association between type of hospital and waste management practices which includes segregation practices, treatment and disposal techniques, waste handling safety measures and waste administration individually.

Type of Hospital

Segregation Practices by Type of Hospital

All Government HCFs (100 percent) were following segregation methods at high level. Among private HCFs, 63.6 percent respondents were following segregation methods at moderate level. Based on this, it can be concluded that the level of segregation methods followed in Government HCFs are good when compared to Private HCFs. Hence there is significant association between type of HCF and segregation methods.

Type of Hospital by Treatment and Disposal Practices

All Government HCFs (100 percent) were following treatment and disposal practices at high level whereas 50.0 percent private HCFs were following at moderate level. It can be concluded that there is significant association between type of hospital and treatment and disposal techniques followed in Government and Private Hospital.

Waste Handling Safety Measures by Type of Hospital

It is observed from the analysis that there is significant association between type of hospital and waste handling safety measures. Majority of Government (87.5 percent) HCFs are following waste handling safety measures at high level. Only 14.4 percent of private HCFs are following safety measures at high level.

Waste Administration by Type of Hospital

All the Government HCFs (100 percent) were following waste administration at high level whereas only 12.7 percent of private HCFs were following waste administration at high level. Government HCFs are having separate department for hospital waste management and also the workers of waste handling are well trained for segregation and treatment. Time interval of waste collection by CBMWTF is also good at Government HCFs when compared to private HCFs. BMW collection without waiting of much time at source is essential to avoid nosocomial infections. The present study covers nearly 12 categories of hospitals.

Category of Hospital

Segregation Practices by Category of Hospital

Significant association was found between category of hospital and segregation practices. Based on category of hospital, segregation methods were different. Other Category HCFs are following segregation methods at high level. Among 4 categories of HCFs, Surgery Category follows segregation methods at moderate level, whereas General Category (40.2 and 56.3 percent) HCFs were following segregation methods at low and moderate level. With the help of Chi-square test, it was found that segregation methods are varying according to the category of hospital.

Treatment and Disposal Practices by Category of Hospital

Among all the categories, only Surgery (80.0 percent) and Others (100.0 percent) were following good treatment and disposal Practices, whereas it is low level in General Category (43.7 percent) HCFs. This clearly indicates that, the treatment and disposal practices are different according to the category. Hence, it can be concluded that there is significant association between category of hospital and treatment and disposal techniques.

For surgery hospitals advanced treatment technologies are essential to prevent occupational diseases.

Waste Handling Safety Measures by Category of Hospital

From the analysis, it is clear that according to category of hospital, waste handling safety measures are varying. All Surgery and Specialized category HCFs are following moderate level of waste handling safety measures whereas under General Category only 19.5 percent HCFs and 87.5 percent in Others category are following safety measures at high level. This analysis clearly indicates that based on the category, waste handling safety measures are different and it is not similar in all the HCFs.

Waste Administration by Category of Hospital

Waste administration is varying with the category of hospital. Waste administration is at high level among General (19.5%) and Others Category (100.0%).

Segregation Practices by Bed Capacity

There is significant association between bed capacity and segregation methods. Segregation practices are at high level in the HCFs with 51 and above bed capacity group, whereas segregation practices were found at low level in 1-10 and 11-20 bed capacity group. The analysis indicates that there is significant impact of bed capacity on segregation methods which was proved with ANOVA and DMRT statistical tools. Further it can be concluded that HCFs having more bed capacity are following segregation practices at high level. The HCFs which are having high bed capacity are also having proportionately high number of waste handling workers. Therefore the segregation practices may be good in the HCFs having more bed capacity when compared to other HCFs.

Treatment and Disposal Practices by Bed capacity

The association between bed capacity, treatment and disposal practices followed in HCFs were studied and concluded that 51 and above bed capacity group are following treatment and disposal practices at high level whereas 44.7 percent HCFs among 11-20 bed capacity group are following at low level. Further, based on ANOVA and DMRT calculations, it is clear that 51 and above bed capacity group are having high impact on

treatment and disposal practices but 31-40, 41-50 bed capacity group is having better impact when compared to 1-10, 11-20, 21-30 bed capacity group.

Waste Administration by Bed Occupancy

No Significant impact was found between bed occupancy and waste administration. Waste administration is similar in less and medium bed occupancy but it is good in large bed occupancy group.

Amount of Waste Generated

Segregation Practices by Amount of Waste Generated

The amount of waste that is being generated from the hospitals was studied and also tried to find the association between amount of waste generation and segregation methods practicing in HCFs. The analysis indicates that amount of waste generation has significant impact on segregation methods

Hence, it can be concluded that there is significant impact on amount of waste generation and segregation practices followed in HCFs.

Treatment and Disposal Practices by Amount of Waste Generated

The difference is significant between the amount of waste generation, treatment and disposal practices employed in HCFs. It is evident that 50.0 percent of HCFs are following treatment practices at high level in less category or upto 200 grams group, 52.6 percent HCFs are moderate and 46.2 percent HCFs are low among very large and medium category amount of waste generation group. It clearly indicates amount of waste generation is significant in treatment and disposal practices employed in HCFs. This was also further proved with one-way ANOVA and DMRT statistical tools. Hence, it is evident that treatment and disposal practices are different with respect to the amount of waste generation.

Waste Handling Safety Measures by Amount of Waste Generated

Significant influence was observed with the amount of waste generation on waste handling safety measures. Significant difference was found among above 600 grams group when compared to the other groups. From the analysis, it can be concluded that based on the amount of waste generation, waste handling safety measures are different.

Waste Administration by Amount of Waste Generated

About 23.1 percent HCFs are having high level, 48.5 percent HCFs are having moderate level and 28.4 percent HCFs are having low level of waste administration among different waste generation groups. Waste administration is good at lesser group category when compared to other groups. One can conclude from the analysis that significant impact was found between amount of waste generation and waste administration.

Segregation Practices by Number of Waste Handling Workers

The analysis indicates that the number of waste handling workers at HCFs have significant influence on segregation practices. The very large group which consists of more than 20 waste handling workers are following high level of segregation practices whereas in very small workers group with 1-5, are following moderate level of segregation practices. It can be concluded that the segregation methods applied are different with the number of waste handling workers. This was also assessed and found that the increase in number of waste handling workers is showing impact on segregation methods at high level. The hypothesis is proved to be accepted in the above aspects.

Waste Handling Safety Measures by Number of Waste Handling Workers

The results reveal that there is significant difference between number of waste handling workers and waste handling safety measures. Increase in number of waste handling workers is having significant impact on following waste handling safety measures in HCFs. Waste handling safety measures are good in large and very large groups.

Conclusions

Developing country like India has seen a tremendous increase in health care facilities from year to year. This leads to an increase in amount of waste generation. When the amount of waste generation is more in quantity, it seeks more attention towards waste management practices employed in health care facilities like segregation, treatment, disposal and waste handling safety measures.

Hence, this study was undertaken with several objectives ranging from studying of amount of waste generation from each bed of individual HCF, BMW segregation methods

and management of waste. Based on the findings and analysis, the following conclusions were drawn related to the following aspects through the various tools of research methodology.

Segregation Practices

Segregation of BMW includes 'segregating at source, using of colour coded bins for collection of BMW, puncture proof containers for temporary storage and separating of sharp waste from non sharp waste' are assessed to observe the segregation practices that are followed in HCFs (INCLIN Program Evaluation Network (IPEN) study group, 2013). The respondents' opinion is drawn taking into consideration the type of hospital, category of hospital, bed capacity, bed occupancy, amount of waste generation and number of waste handling workers.

The study reveals that there is significant association between all the characteristics of HCFs and segregation methods employed at hospitals. Segregating waste at the point of generation is very important in the management and handling of Bio-Medical waste. It is the first and foremost step and also it is prescribed that BMW should not be mixed with other types of waste. From the results of the present study, it was found that majority of the respondents (42.5 percent) are segregating the waste at source only through which one can avoid mixing of infectious waste with non-infectious waste. It was prescribed in schedule II about usage of colour coded bins. However it is strictly followed in majority of HCFs (61.2 percent). By using of colour coded bins to store and transport waste after segregation at source, one can minimize the contamination of waste. While storing and transporting of waste, HCFs has to use puncture proof containers in accordance with the rules of segregation. 91 percent HCFs are using colour coded bins for segregation of infectious waste. The rules also laid down in segregation of source from sharp waste to non-sharp waste where maximum amount of risk can be avoided. Majority HCFs (59 percent) are following sharps segregation strictly according to the rules and regulations (Ramesh babu et al., 2008). The segregation at source would help for proper waste treatment and management and minimizes health risk among health care employees as well as to the environment.

Treatment and Disposal Practices

Treatment and disposal practices employed are very important among waste management practices. According to rules prescribed in Schedule V, depending on the categories of waste, their methods of treatment varies with the using of scientific standards for operating technical instruments like incinerators, autoclaves and microwave etc. However, majority of the respondents (100.0 percent) did not possess incinerators, autoclave, shredder and pyrolysis unit among all HCFs in Chittoor District but majority of HCFs are using needle burner frequently. 94 percent of the respondents were registered with CBMWTF for outsourcing of BMW treatment. Many HCFs are not having landfill facility as they are utilizing outsourcing facility whereas 88.1 percent of HCFs are releasing their microbial waste into public drains and gutters which is a big havoc to the eco system and as a result many more antibiotic resistant super bugs are being created everyday

Waste Handling and Safety Measures

Based on the literature, questions were constructed on waste handling safety measures like using of protective gears, trollys, washing of hands and spillages which will help to observe the impact on characteristics of HCFs.

The current BMW handling and safety measures followed in many HCFs are observed and identified that usage of protective gears is less. Only 26.9 percent HCFs are using protective gears regularly. Majority of the HCFs are not using trolleys for transportation of BMW to the disposal site. As a result waste handling workers have to handle BMW manually. During that process they are prone for getting needle stick/sharp injuries, if not provided protective gears. Using trolleys will also help to minimize the spillages within the HCF premises. It was identified that majority of HCFs that spillages are common (41.0 percent). The spillages are proved to be the breeding places for many microbes. During the process of waste handling, workers have to maintain hygienic environment. When they are assisting for the doctors, they may be in contact with many medical instruments. If their hands are not washed properly, they may spread the infectious agents. Hence, hand washing methods are essential. Majority HCFs responded that they are using soap and water for hand washing instead of alcoholic gels. Using alcoholic gel is very much essential for hospital staff. The practice of using sanitizers is to be encouraged

and inculcated among health care workers. From the BMW stream, sharp waste is potentially infectious or hazardous and the most immediate threat to human health is the indiscriminate disposal of sharps (needles, syringes, broken vials and invasive tools). Even though it constitutes the smallest fraction of these wastes, utmost attention is needed for segregation and disposal as 50.7 percent HCFs revealed that sharp injuries are common for waste handling workers.

As a result healthcare workers are exposed to biological, chemical and infectious contaminants and also for dioxins. This needs immediate attention to improve the status among healthcare units in waste handling and safety measures.

Suggestions

Based on the findings of the study the following suggestions were made for both Government and individual HCFs.

Recommendations to the Government

- From the present study, it is clear that the CBMWTFs in India are insufficient for treatment of waste generated every day. Therefore, there is a dire necessity to increase CBMWTFs to minimize the untreated waste. This would help to protect the environment from contamination.
- Similar observations were made for the Andhra Pradesh State to increase the CBMWTFs. It is suggested that the Government should encourage to establish in-house treatment practices in the major HCFs which are having more than 200 bed capacity. This would tremendously reduce BMW treatment cost. Using of advanced technologies is very much essential to minimize air effluents emanated from the incinerator. This would facilitate to establish in-house treatment facilities in densely populated areas like cities and towns.
- There should be a separate department for BMW management as well as health risk assessment to reduce the risk of infectious diseases among occupational health care workers. This department must conduct periodical training as well as awareness programmes on the ill effects of hospital waste due to improper segregation, handling and disposal methods.

- Creating awareness to each and every waste handling workers on hand hygiene methods to minimize the risk of infections.
- There is a need for strict enforcement of legal provisions and a better environmental management system for the disposal of biomedical waste in all the Healthcare facilities in India.

Suggestions to the Hospitals

- All HCFs must follow the norms prescribed by Pollution Control Board strictly.
- Usage of colour coded and puncture proof bins must be a mandated for all HCFs to prevent mixing of infectious and non-infectious waste.
- All hospitals have to monitor waste generation and disposal practices regularly.
- There should be a separate wing to monitor the needle stick/ sharp injuries to minimize the spread of infectious diseases
- All the HCFs should take appropriate measures to avoid illegal/illegitimate segregation of BMW by rag pickers.
- Waste handling workers should be provided with protective masks and gloves to protect from infectious agents.
- Cost effective and eco-friendly methods like photo chemical degradation can be adopted for waste treatment.



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