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Medical waste management and environmental pollution control in Coimbatore city

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Abstract
Medical waste, due to its content of hazardous substances, poses serious threats to environmental health. The hazardous substances include pathological and infectious material, sharps, and chemical wastes. In hospitals, different kinds of therapeutic procedures (i.e. cobalt therapy, chemotherapy, dialysis, surgery, delivery, resection of gangrenous organs, autopsy, biopsy, para clinical test, injections etc.) are carried out and result in the production of infectious wastes, sharp objects, radioactive wastes and chemical materials. The study reveals that there is no proper, systematic management of medical waste except in a few private medical industry that segregate their infectious wastes. The study also shows that a newly designed medical waste management system currently serves a limited number of industries involved in the medical field. To examine the dumping of medical pollutants by the medical industries in Coimbatore. The objectives are to analyze the effective measures taken to dispose the medical pollutants by the medical industries, to find out the staff improvement in segregating, handling and disposing the medical waste in a proper manner and finally, to examine the government support to dispose the medical wastes and to offer remedial measures to save the environment from the medical pollutants. The companies selected are not-listed specifically since the health care sector covers different nature which do not have a definite identification. Apart from that personal discussions with officials of the concerns also helps to enhance the required information. The total population is listed from the database, however, around 200 respondents were covered randomly. The sample size was adopted as 200 medical industries from different parts of Coimbatore City which contains innumerable in number which cannot be exacted. The researcher randomly selected these 200 medical related industries and the opinions on the various aspects of medical pollutants were collected by distributing questionnaire. The study was limited within the medical industries existing to the limitation of the geographical location of Coimbatore It is concluded that not only in our city taking into consideration the whole country, medical waste management systems to reduce the environmental and public health risk are grossly inadequate.

Keywords: Medical waste, Medical Pollutants, Hazardous substances, etc.

Introduction

Medical waste, due to its content of hazardous substances, poses serious threats to environmental health. The hazardous substances include pathological and infectious material, sharps, and chemical wastes. In hospitals, different kinds of therapeutic procedures (i.e. cobalt therapy, chemotherapy, dialysis, surgery, delivery, resection of gangrenous organs, autopsy, biopsy, para clinical test, injections etc.) are carried out and result in the production of infectious wastes, sharp objects, radioactive wastes and chemical materials. Medical waste may carry germs of diseases such as hepatitis B and AIDS. In developing countries, medical waste has not received much attention and it is disposed of together with domestic waste. Improper medical waste management is alarming in Bangladesh and it poses a serious threat to public health.

Medical waste contains highly toxic metals, toxic chemicals, pathogenic viruses and bacteria, which can lead to pathological dysfunction of the human body. Medical waste presents a high risk to doctors, nurses, technicians, sweepers, hospital visitors and patients due to arbitrary management. It is a common observation in Dhaka City that poor scavengers, women and children collect some of the medical wastes (e.g. syringe-needles, saline bags, blood bags etc.) for reselling despite the deadly health risks. It has long been known that the re-use of syringes can cause the spread of infections such as AIDS and hepatitis. The collection of disposable medical items (particularly syringes), its re-sale and potential re-use without sterilization could cause a serious disease burden. The safe disposal and subsequent destruction of medical waste is a key step in the reduction of illness or injury through contact with this potentially hazardous material, and in the prevention of environmental contamination. The transmission of blood-borne viruses and respiratory, enteric and soft tissue infections through improper medical waste disposal is not well described. The management of medical waste therefore, has been of major concern due to potentially high risks to human health and the environment.

Medical wastes are generated as a result of patient diagnosis and/or treatment or the immunization of human beings or animals. The subset of medical waste that potentially could transmit an infectious disease is termed *infectious waste.* The Centers for Disease Control (CDC), the U.S. Environmental Protection Agency (EPA), and the World Health Organization (WHO) concur that the following wastes should be classified as infectious waste: sharps (needles, scalpels, etc.), laboratory cultures and stocks, blood and blood products, pathological wastes, and wastes generated from patients in isolation because they are known to have an infectious disease. Medical wastes can also include chemicals and other hazardous materials used in patient diagnosis and treatment. In some cases this subset of

medical waste is classified as hazardous waste. Hospitals, clinics, research facilities, diagnostic labs, and other facilities produce medical waste. The bulk of the wastes generated by most health care facilities, however, is municipal solid waste (MSW), or trash. MSW includes large quantities of paper, cardboard and plastics, metals, glass, food waste, and wood. Medical waste, though a smaller portion of the total health care waste stream, is of special concern because of the potential hazards from pathogens that may be present, or from hazardous chemicals.

Statement of the problem

Medical waste is infectious and hazardous. It poses serious threats to environmental health and requires specific treatment and management prior to its final disposal. A structured questionnaire was designed to collect information addressing the generation of different medical wastes according to amount and sources from different Hospitals, Health Care Centres and medical related industries. The study reveals that there is no proper, systematic management of medical waste except in a few private medical industry that segregate their infectious wastes. The study also shows that a newly designed medical waste management system currently serves a limited number of industries involved in the medical field. New facilities should be established for the complete management of medical waste not only in Coimbatore City but also for the whole country.

Objectives of the Study

- To analyze the effective measures taken to dispose the medical pollutants by the medical industries.
- To find out the staff improvement in segregating, handling and disposing the medical waste in a proper manner.
- To examine the government support to dispose the medical wastes and to offer remedial measures to save the environment from the medical pollutants.

Scope and Significance of the Study

The growing number of hospitals, clinics, and diagnostic laboratories in Coimbatore City exerts a tremendous impact on public health and environment. All of the hospitals, clinics, and diagnostic laboratories are considered here as the HCE. Some 600 HCE in the city generate about 200 tons of waste a day. Like ordinary household waste, medical wastes are generally dumped into bins. It is reported that even body parts are dumped on the streets by the HCE. The liquid and solid wastes containing hazardous materials are simply dumped into the nearest drain or garbage heap respectively. Hence it is important to take up this study to find solutions to overcome the environmental issues created by Medical Wastes.

Methodology

The study concerned with specific predictions, with narration of facts & characteristics concerning individual, group or situation are all examples of descriptive research studies. The data was collected from both primary and secondary sources. The primary data was collected through structured questionnaire using stratified random sampling technique. The secondary data was collected through files, magazines, periodicals and Websites. Companies of the Health care industries in Coimbatore are randomly selected from the list available in the yellow pages, etc. databases for the purpose of this study. The companies selected are not-listed specifically since the health care sector covers different nature which do not have a definite identification. Apart from that personal discussions with officials of the concerns also helps to enhance the required information. The total population is listed from the database, however, around 200 respondents were covered randomly. The sample size was adopted as 200 medical industries from different parts of Coimbatore City which contains innumerable in number which cannot be exacted. The researcher randomly selected these 200 medical related industries and the opinions on the various aspects of medical pollutants were collected by distributing questionnaire. The technique used for the research is Probability Sampling because the population is finite. The Sampling technique selected for the study is Stratified random sampling technique. Because the researcher knew that there are innumerable medical related industries in the city, the researcher conducted the study only with selectively with few industries in Coimbatore City. The collected data was carefully coded and transited to SPSS Package. With this the tabulation was made in scientific and systematic way. further, the collected data was classified, tabulated and analyzed using simple percentage method. The statistical tool adopted to analyze the data gathered is Chi Square Test and ANOVA.

Limitations of the Study

It is found that the respondents in the industry possess liabilities to the company, hence a chance of personal bias are there in the study. The study was limited within the medical industries existing to the limitation of the geographical location of Coimbatore, hence it lacks universal applicability, that means this analysis cannot be applied to similar type of industry or situation in any other area.

Analysis and Results

Table 1: Distribution of Respondents Opinion

Type of Industry	Respondents (200 Nos.)	Percentage (100%)
Physician and Dental Offices	55	28%
Animal Cremation or Experimentation Facilities	2	1%
Disaster Relief Operations	2	1%
Health Agencies and Organizations	31	16%
Hospice Agencies	2	1%
Laboratories	27	14%
Psychiatric Facilities	25	13%
Small Hospitals, Clinics, and Blood Banks	56	28%

Type of Industry	Respondents (200 Nos.)	Percentage (100%)
Opinion on Industry handling with hazardous substances		
Yes	152	76%
No	48	24%
Type of hazardous substance		
Pathological	8	4%
Infectious material	68	34%
Sharps	25	13%
Chemical wastes	11	5%
Sharps & Infectious material	40	20%
NA	48	24%
If hospital		
Delivery	10	5%
Delivery & Sugery	6	3%
Dialysis	6	3%
Injections	4	2%
Injections, Delivery, Surgery	28	14%
Injections, etc.	51	26%
Injections, Surgery	39	20%
NA	36	18%
Surgery	20	10%

Source: Primary Data

From the above table it is clear that maximum (28%) of the respondents are engaged in Small Hositals, Clinics and Blood Banks, another 28% of the respondents are Physicians and Dental Offices, 16% of the respondents are in health agencies and organisations, 14% of the respondents are scattered as Laboratories, 13% of the respondents are engaged in Psychiatric facilities, 1% each of the respondents are in disaster relief operations, hospice agencies and animal cremation or experimentation facilities. Majority (76%) of the respondents industry are handling with hazardous substances and 24% of the respondents industry are not handling hazardous substances. Maximum (34%) of the respondents opined that their organization is handling infectious type of hazardous substances, 24% of the respondents opined not applicable, 20% of the respondents stated their industry handling sharps and infectious material, 13% of the respondents indicates their industry handling with sharps, 5% of the respondents opined chemical wastes and the remaining 4% of the respondents said that their industry handling pathological type of material. 26% of the respondents opined that their hospital is handling with therapeutic procedures by the hospital industry such as injections, etc., 20% of the respondents stated injections, surgery, etc., 18% of the respondents do not come in the hospital category, 14% of the respondents indicated injections, delivery, surgery, etc., 10% of the respondents expressed surgery, 3% each of the respondents opined delivery and surgery, dialysis and the remaining 5% and 2% of the respondents stated delivery and injections respectively.

Table 2: Respondents opinion about the trainees capabilities on the factors after training

Factors	Strongly agree		Agree		Disagree		Total	
	No. of resp.	%	No. of resp.	%	No. of resp.	%	No. of resp.	%
Proper identification	38	46%	32	39%	12	15%	82	100%
Segregation	42	51%	29	35%	11	13%	82	100%
Handling	45	55%	25	30%	12	15%	82	100%

Source: Primary Data

The above table shows that less than half (59%) of the respondents strongly agree that their house keeping staff are capable of proper identification after training, 32% of the respondents agree and the remaining 15% of the respondents disagree. When taking into consideration the segregation of material more than half (51%) of the respondents strongly agree that their staff are capable of segregating the medical waste after training, 35% of the respondents agree and the remaining 15% of the respondents disagree. It is clear from the above table that more than half (51%) of the respondents strongly agree that their staff are capable of segregating the medical waste after training, while 30% of the respondents agree and the remaining 15% of the respondents disagree.

Table 3: Respondents opinion the type of facilities that the government can employ / support with

Opinion	Number of respondents	Percentage
Medical Waste Incinerators	43	22%
Trash Incinerators	94	47%
Drug disposal incinerators	63	32%
Total	200	100%

Source: Primary Data

The above table shows that less than half (47%) of the respondents needed the government to facilitate with the trash incinerators, 32% of the respondents opined drug disposal incinerators and the remaining 22% of the respondents opined that they need to be supported with medical waste incinerators.

Table 4: Respondents opinion about the priorities to overcome their problem

priority	Number of respondents	Percentage
More awareness	54	27%
More facilities	75	38%
More Government Aid	71	35%
Total	200	100%

Source: Primary Data

The above table shows that maximum (38%) of the respondents needed more facilities as their priorities to overcome the medical waste pollution problem, 35% of the respondents opined more government aid needed and the remaining 27% of the respondents stated that they need to ensure more awareness to overcome the medical waste pollution problem.

Table 5: Respondents opinion about the improvement at present in prevention of environmental pollution when compared to the past

Opinion	Yes		No		Total	
	No.	%	No.	%	No.	%
Definitely improved	92	46%	28	24%	120	60%
Partially Improved	60	30%	20	10%	80	40%
Total	152	76%	48	34%	200	40%

Source: Primary Data

The above table shows that 46% of the respondents stated that there is improvement at present in prevention of environmental pollution when compared to the past, 30% of the respondents stated partially improved and the remaining 34% of the respondents felt that there is no improvement at present in prevention of environmental pollution when compared to the past.

b) Chi-Square Test

Table 6: Relationship between disposing method followed by the medical industry and the disease carried due to improper disposal

Disposing method	Disease carried			Total
	AIDS	Hepatitis B	Others	
Almost	0	10	0	10
	2.0	6.7	1.4	10.0
Always	24	19	4	47
	9.4	31.3	6.3	47.0
Never	0	32	0	32
	6.4	21.3	4.3	32.0
Sometimes	16	72	23	111
	22.2	73.8	15.0	111.0
Total	40	133	27	200
	40.0	133.0	27.0	200.0

Source: Computed

The result of the chi-square test reveals that the calculated chi-square value (55.569) is more than the table chi-square value (12.592) at 5% level of significance and therefore, the relationship between disposing method followed by the medical industry and the disease carried due to improper disposal is significant. Thus the hypothesis is that the relationship between the two factors holds good. Hence the null hypothesis is rejected.

Table 7: Relationship between disease carried due to improper disposal and opinion about using incinerators by the medical industry

Disease carried	Using incinerators		Total
	Yes	No	
Hepatitis B	110	23	133
	111.1	21.9	133.0
AIDS	40	0	40
	33.4	6.6	40.0
Others	17	10	27
	22.5	4.5	27.0
Total	167	33	200
	167.0	33.0	200.0

Source: Computed

The result of the chi-square test reveals that the calculated chi-square value (16.230) is more than the table chi-square value (12.592) at 5% level of significance and therefore, the relationship between disease carried due to improper disposal and opinion about using incinerators by the medical industry is significant. Thus the hypothesis is that the relationship between the two factors holds good. Hence the null hypothesis is rejected.

Table 8: Relationship between disposing method followed by the medical industry and frequency of removal

Disposing method	Frequency of removal				Total
	Every day	Every month	Once in a week	Twice a week	
Almost	1	0	3	6	10
	3.5	1.1	2.6	2.9	10.0
Always	19	0	18	10	47
	16.2	5.2	12.2	13.4	47.0
Never	16	0	2	14	32
	11.0	3.5	8.3	9.1	32.0
Sometimes	33	22	29	27	111
	38.3	12.2	28.9	31.6	111.0
Total	69	22	52	57	200
	69.0	22.0	52.0	57.0	200.0

Source: Computed

The result of the chi-square test reveals that the calculated chi-square value (38.048) is more than the table chi-square value (16.919) at 5% level of significance and therefore, the relationship between disposing method followed by the medical industry and frequency of removal is significant. Thus the hypothesis is that the relationship between the two factors holds good. Hence the null hypothesis is rejected.

c) Weighted Mean

Table 9: opinion about the trainees capabilities on the factors after attending training

Factors	Rank-1	Rank-2	Rank-3	Total
Proper identification	38	32	12	2.32
Segregation	42	29	11	2.38
Handling	45	25	12	2.40

Source: Computed

The above table reveals that majority of the score (2.38) was obtained by the staff who is capable of handling of medical pollutants after attending the training followed by segregation with a score of 2.38 and finally (2.32) the proper identification was the factor of capabilities obtained by the staff after attending the training.

d) ANOVA

Table 10: Variance between waste connection done by the staff in the medical industry and disease carried due to improper disposal

Source of Variation	SS	d.f.	Mean Square	F-ratio	5% F-limit
Between Columns	534	(3-1) = 2	267.11	1.66	F(2,4)= 6.94
Between Rows	2228	(3-1) =2	1114.11	6.91	F(2,4)= 6.94
Residual of error	645	3 x 3 = 4	161.28		
Total	3408	(3 x 3)-1 = 8			

Source: Computed

The table value at 5% level of significance and the calculated F Ratio is 1.66 between columns and 6.91 between rows. The calculated value is less than the table value between columns and the calculated value which is also less than the table value between rows. Hence there is no significant variance between waste connection done by the staff in the medical industry and disease carried due to improper disposal

Table 11: Variance between opinion about the availability of alternative method and need for the alternative method

Source of Variation	SS	d.f.	Mean Square	F-ratio	5% F-limit
Between Columns	1480	(4-1) = 3	493.33	6.68	F(3,3)=9.28
Between Rows	841	(2-1) =1	420.25	5.69	F(3,1)=10.13
Residual of error	222	3 x 1 = 3	73.83		
Total	2542	(4 x 2)-1 = 7			

Source: Computed

The table value at 5% level of significance and the calculated F Ratio is 6.68 between columns and 5.69 between rows. The calculated value is less than the table value between columns and the calculated value which is also less than the table value between rows. Hence there is no significant variance between opinion about the availability of alternative method and need for the alternative method

Table 12: Variance between opinion about the Type of hazardous substance and method of disposing

Source of Variation	SS	d.f.	Mean Square	F-ratio	5% F-limit
Between Columns	1464	(4-1) = 3	488.04	12.47	F(3,15)=3.29
Between Rows	1086	(6-1) =5	217.27	5.55	F(5,115)=2.90
Residual of error	587	3 x 5 = 15	39.12		
Total	3137	(4 x 6)-1 = 23			

Source: Computed

The table value at 5% level of significance and the calculated F Ratio is 12.47 between columns and 5.55 between rows. The calculated value is more than the table value between columns and the calculated value which is also more than the table value between rows. Hence there is significant variance between opinion about the Type of hazardous substance and method of disposing.

Table 13: Variance between opinion about the Disease carried due to unsafe handling of waste and Frequency of removal of Waste

Source of Variation	SS	d.f.	Mean Square	F-ratio	5% F-limit
Between Columns	399	(4-1) = 3	133.11	3.73	F(3,6)=4.76
Between Rows	1671	(3-1) =2	835.58	23.41	F(2,6)=5.14
Residual of error	214	3 x 2 = 6	35.69		
Total	2285	(4 x 3)-1 = 11			

Source: Computed

The table value at 5% level of significance and the calculated F Ratio is 3.73 between columns and 23.41 between rows. The calculated value is less than the table value between columns and the calculated value which is more than the table value between rows. Hence there is significant variance between opinion about the Disease carried due to unsafe handling of waste and Frequency of removal of Waste

Summary of Findings, Suggestions and Conclusion

- maximum (28%) of the respondents are engaged in Small Hositals, Clinics and Blood Banks
- majority (76%) of the respondents industry are handling with hazardous substances.
- maximum (34%) of the respondents opined that their organization is handling infectious type of hazardous substances.
- 26% of the respondents opined that their hospital is handling with therapeutic procedures by the hospital industry such as injections, etc.
- less than half (59%) of the respondents strongly agree that their house keeping staff are capable of proper identification after training, more than half (51%) of the respondents strongly agree that their staff are capable of segregating the medical waste after training and more than half (51%) of the respondents strongly agree that their staff are capable of segregating the medical waste after training
- less than half (47%) of the respondents needed the government to facilitate with the trash incinerators.
- maximum (38%) of the respondents needed more facilities as their priorities to overcome the medical waste pollution problem
- 46% of the respondents stated that there is improvement at present in prevention of environmental pollution when compared to the past
- The calculated chi-square value (55.569) is more than the table chi-square value (12.592) at 5% level of significance and therefore, the relationship between disposing method followed by the medical industry and the disease carried due to improper disposal is significant. Thus the hypothesis is that the relationship between the two factors holds good. Hence the null hypothesis is rejected.
- The calculated chi-square value (16.230) is more than the table chi-square value (12.592) at 5% level of significance

and therefore, the relationship between disease carried due to improper disposal and opinion about using incinerators by the medical industry is significant. Thus the hypothesis is that the relationship between the two factors holds good. Hence the null hypothesis is rejected.

- The calculated chi-square value (38.048) is more than the table chi-square value (16.919) at 5% level of significance and therefore, the relationship between disposing method followed by the medical industry and frequency of removal is significant. Thus the hypothesis is that the relationship between the two factors holds good. Hence the null hypothesis is rejected.
- Majority of the score (2.38) was obtained by the staff who is capable of handling of medical pollutants after attending the training followed by segregation with a score of 2.38 and finally (2.32) the proper identification was the factor of capabilities obtained by the staff after attending the training.
- It is clear that there is no significant variance between waste connection done by the staff in the medical industry and disease carried due to improper disposal
- It is clear that there is no significant variance between opinion about the availability of alternative method and need for the alternative method
- It is observed that there is significant variance between opinion about the Type of hazardous substance and method of disposing
- It is found that there is significant variance between opinion about the Disease carried due to unsafe handling of waste and Frequency of removal of Waste

Suggestions

A number of in-depth interviews should be arranged to get a greater understanding of the existing management practice of medical wastes. In-depth interviewing is a highly personal process where meanings are created through personal interaction. A number of specific questions should be asked of nurses, hospital managers, doctors, and cleaners for eliciting their understandings.

Proper management of medical waste is crucial to minimise health risks. The improvement of present waste management practices will have a significant long-term impact on minimising the spread of infectious diseases. Medical waste requires specialized treatment and management from its source to final disposal. Simply disposing of it into dustbins, drains, and canals or finally dumping it to the outskirts of the City poses a serious public health hazard, which were also considered as pollution to the public Health and Environmental Safety. Thus, there is a need to initiate a concentrated effort to improve the medical waste management to reduce the negative impact of waste on: (a) environment; (b) public health; and (c) safety at health care facilities. There are different types of medical waste management systems in different countries. Although, medical waste disposal options are not completely risk-free, the risks can be minimized with care. Improper disposal of medical waste may include damage to humans by sharp instruments, diseases transmitted to humans by infectious agents, and contamination of the environment by toxic and hazardous chemicals. Therefore, proper management of medical waste is a subject of major concerns for a healthy environment.

Conclusion

The waste generation rates in the surveyed medical industries were obtained by actual measurements and through assessment of the storage facilities emptying frequencies and the degree of filling of the refuse receptacles. Different wastes were used to store in different sizes of buckets in different wards, and surgery departments. The weight of these wastes was then measured in kilograms. The quantity of waste in different categories was collected twice in a day when the refuse receptacles emptied, but, in surgery departments, nurses provided us additional information regarding the quantity of generated wastes. We were very careful about our data and nurses were helpful in gathering the relevant information. The WHO guidelines should be followed to categorize the generated wastes from different medical industries in the study sites. It is concluded that not only in our city taking into consideration the whole country, medical waste management systems to reduce the environmental and public health risk are grossly inadequate.

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