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An Infrastructural Survey on Biomedical Waste Management in Nashik City

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Abstract: ***Population of Nashik city is 2, 180,000. In this city 825 health care units, 10 corporation hospitals, 6 city health clinics, 4 mobile dispensaries are present. The figure is even more than this. Total numbers of beds are 6,200 and biomedical waste generated is about 2,500 kg/day. It is crucial to manage and treat biomedical waste generated from all health care units present in the city to avoid both health as well as environmental hazards. This analytical study has been conducted in the year of 2007-2008 intended to perceive Biomedical waste management practices implemented by various categories of hospitals from different zones of Nashik city. Total fifty seven hospitals was visited with pretested structured questionnaire. Data were analysed by using statistical Chi square ($\chi 2$) test by using 2 x 2 contingency table. The study concludes that healthcare waste management should go beyond data compilation, enforcement of regulation and acquisition of better equipment.***

Keywords: Biomedical Waste Management, Biomedical Waste Treatment, Health And Environmental Hazards, Nashik City, Statistical Analysis

1. INTRODUCTION

Hospitals are known for medical treatment of sick persons which are frequented by people from every walk of life but, we are ignorer about the harmful effects of waste generated from hospitals, health care teaching institutes, research institutions, blood banks, clinics, laboratories, veterinary institutes and animal houses etc. The Bio-Medical Waste (Management and Handling) Rules, 1998 was published vide notification number S.O. 630 (E) dated the 20th July, 1998, by the Government of India in the Ministry of Environment and Forests, gave a regulatory frame work for management of bio-medical waste generated in the country (Sutha Irin ,2018).It is revised in 2016.Although these rules exist to reduce the consequences of hazardous and contagious hospital waste on the community, still all these are yet to be fully

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implemented. Most of the authentic studies which has been studied during project work revealed the absence of proper waste management, lack of awareness about the health hazards from biomedical wastes, insufficient financial and human resources, and poor control of waste disposal are the most critical problems connected with healthcare waste.(Gupta S. ; Boojh R.,2006).

Disposal of medical waste promotes mechanical transmission of fatal diseases like Diarrhea, Dysentery, Typhoid, Hepatitis and Cholera under moist condition mosquitoes transmit many types of infections like Malaria and yellow fever, similarly dogs, cats and rats also transmit a variety of disease including plague and flea born fever. A high tendency of contracting intestinal, parasitic and skin diseases found in workers engaged in collecting waste. Radioactive waste requires sophisticated treatment and management in order to successfully isolate it from interacting with the biosphere. (Maheshkumar M. et al., 2014)

Biomedical waste rules were framed under Environment Protection Act which prescribes total thirteen rules and six schedule. Out of which Schedule I is an important which illustrates details about disposal and treatment. (Acharya D.B.; Singh Meeta., 2000)

Table 1. Categories of Bio-medical waste (Schedule I)

Option	**Waste Category**	**Treatment & Disposal**
1	2	3
Category No.1	Human Anatomical Waste (human tissues, organs, body parts)	incineration@/deep burial*
Category No.2	Animal Waste (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospital colleges, discharge from hospitals, animal houses).	incineration@/deep burial*
Category No.3	Microbiology and Biotechnology Waste (waste from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of bio-logicals, toxins, dishes and devices used for transfer of cultures)	local autoclaving/micro-waving/ incineration@
Category No.4	Waste Sharps (Needles, syringes, scalpels, blades, glass etc. that may cause puncture and cuts. This includes both used and unused sharps)	Disinfection (2chemical treatment@@/ autoclaving/micro- waving and multilation/shredding##

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Category No.5	Discarded Medicines and Cytotoxic drugs (Wastes comprising of outdated, contaminated and discarded medicines.	incineration@/descturction and drugs disposal in secured landfills.
Category No.6	Solid Waste (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)	incineration@/autoclaving/ microwaving
Category No.7	Solid Waste (Wastes generated from disposable items other than the waste sharps such as tubbings, catheters, intravenous sets etc.)	Disinfection by chemical treatment @@/autoclaving/microwaving and multilation/shredding##
Category No.8	Liquid Waste (Waste generated from laboratory and washing, cleaning, housekeeping and disinfeeting activities) discharge into drains	Disinfection by chemical treatment @@ and discharge into drains.
Category No.9	Incineration Ash (ash from incineration of any bio-medical waste)	Disposal in municipal land fill.
Category No.10	Chemical Waste (Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides etc.)	Chemicals treatment @@ and discharge into drains for liquids and secured land fill for solids.

[Source: http://mpcb.gov.in/biomedical/pdf/BMW_Rules_2016.pdf.G.S.R.343 (E)]

Objectives of the study

- To make a general survey of various hospitals in Nashik City and categories as per their specialization.
- To know the current practices implemented by different hospitals for hospital waste management.
- To study the various policies for hospital waste management (current status of hospital).
- To know about the most hazardous biomedical waste and its immediate disposal.
- To enumerate different hazards caused by improper disposal of hospital waste.

Findings of the study

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Fig.1 Needle Destroyer Used in hospitals

Fig.2 Yellow Colour coded bag used for collection of Placenta in Mehta Gynaecology Hospital

Fig.3 Open dumping of colour coded bags in Civil Hospital

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The open dumping of the waste makes it freely accessible to rag pickers who become exposed to serious health hazard due to injuries from sharps, needles and other type of infections waste and these rag pickers becomes an agent for various diseases transmission. (Mishra kirti, et al. , 2016)

Fig.4 Small Incineration Plant at Maharashtra T.B. Sanitorium

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Common Biomedical Waste Treatment facility (CBWTF)

Keeping in view the foregoing, Nashik Municipal Corporation has started Bio-medical waste disposal plant on "Boo" basis with water grace products Nashik. (Boo basis means, Bio-medical waste, occupiers, and operator). In this context, Nashik Municipal Corporation has come forward to develop a common incineration, autoclaving and shredding facility for Bio-medical waste to protect environment and health of the residents of Nashik City. The project is situated in Survey No. 406, Near Kannamvar Bridge, Nashik City. The facility is provided for safe collection, transportation and disposal of Bio-medical waste with the help of advanced technology as well as to ensure the safe disposal of ash till it is sent for land fill site as per the norms of Central Government.

The common incineration facility is available to all medical practitioners in the city of Nashik on chargeable basis. The charges are fixed by Nashik Municipal Corporation. The charges are irrespective of bed strength.

Services provided by this facility are Collection of BMW in biodegradable and incinerable bags. Transportation with the help of specially designed vehicles as per the rules of CPCB and MPCB.Treatment of BMW by incineration, autoclaving and shredding as shown in figure 5,6,7,8 which are clicked photographs at the time of field visit. Storage and transportation of ash at the land fill site. (http://cpcb.nic.in/BMW/ Nashik)

The waste must be treated under the guidance of trained persons and at suitable operating conditions. Therefore, off-site incineration i.e. at common biomedical waste treatment facility is better than on-site because if waste is burned in open space, emissions of pathogenic microorganisms to the environment may occur through the release of aerosols or in the water. (Becher, S.; Lichtnecker, H., 2002) However, the survey shows that only 8.77% hospitals treat their biomedical waste on-site. The wastes generated from dental clinics are treated on-site. It was observed that NGO hospital Maharashtra T.B. Sanitorium also treat their waste on-site although it is highly infectious. [Figure 4]

Table 2. The charges for hospitals to CBWTF.

	Charges in Rs.
a) Occupier with 1-50 beds	Rs. 350 / day / bed (minimum Rs. 500/-)
b) Occupier with 51-200 beds	Rs. 300 / day /bed
c) Occupier with 201-500 beds	Rs. 250 / day / bed
d) Occupier with 501-above	Rs. 200 / day /bed
e) Occupier with only consulting	Rs. 200 per month
f) Occupier with dispensary without beds	Rs. 300 per month
g) Dental Clinics	Rs. 500 per month
h) Pathological labs, Blood banks, Eye banks, Mild banks, Semen Banks, Organ Transplantation	Rs. 500 per month
i) Veterinary hospitals, dispensaries, artificial insemination centers	Rs. 500 per month
j) All educational institutions, laboratories where animals are reared/killed or used	Rs. 200 per month

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[Source: http://cpcb.nic.in/BMW/ status of common biomedical waste treatment facility in Nashik city.]

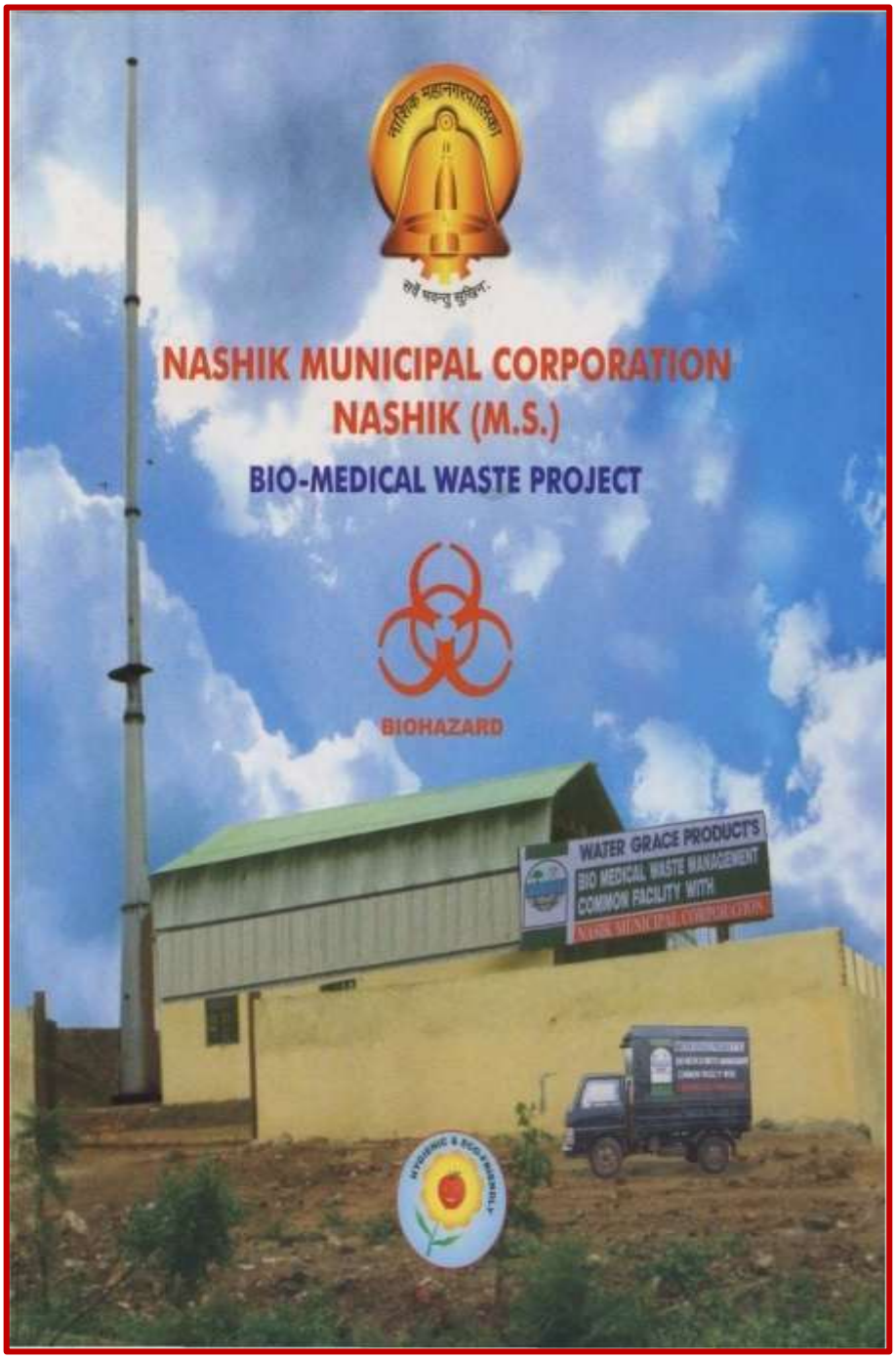

Fig.5 Common Biomedical Waste Treatment facility (Water Grace Products), Nashik

Table 3. Fact sheet of common treatmentfacility For Management of Biomedical Waste of Nashik City

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Sr.No.	Common BMW Management facility	Nashik
1	Name of the Operator/ Agency	M/s Water Grace Products
2	Location	S.No.406, Near Kannamwar Bridge Nashik City
3	Facility provided	
	Incinerator	300 kg/hr
	Autoclave	200 kg/hr 50-60 kg/batch
	Shredder	75 kg/hr
4	No. of health care units from which BMW receives waste	825
5	No. of beds	6200 beds
6	BMW generated in city	2500 kg/day
7	BMW received incinerable / non incinerable	2000 kg/day
8	Record keeping	
	Daily individual collection	Not maintained
	Waste received	Not maintained
	Incinerator operation	Not maintained
	Autoclave operation	Not maintained
9	Observations:	
	A) Incinerator operation Temperature of primary & secondary chamber	Maintained adequately
	Scrubber	Provided
	Treatment for scrub liquid	Adequate
	Disposal of Ash	Municipal solid waste
	B) Autoclave operation	Yes
	Records of operation	Not maintained
	C) Segregation of waste	Not proper
	D) Transportation of BMW vehicle	Provided
	E) Space available	Adequate
10	Facilities carried by MPCB Emission limits	
	Particulate matter	150 mg/nm^3
	Nitrogen oxide	450 mg/nm^3
	Hydrochloric acid	50 mg/nm^3

[Source: http://www.nashik corporation.com / Fact sheet of common biomedical waste treatment facility.]

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Thus bio-medical waste disposal plant i.e. water grace product's is try to fulfilling all the terms and conditions as per the rules but, most of the medical practitioners are disagreed with this facility because they wish to start their own project with the cooperation of Indian Medical Association (IMA) which is rejected because of some difficulties. Further the cost of treatment and disposal of Bio-medical waste is high which are not affordable for smaller health care establishments. Most of the health care practioner recommends that,the cost should be according to waste volume and not according to bed strength.

Fig.6 Common incineration facility at ((Water Grace Products), Nashik

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Fig. 7 Flue Gas Treatment at ((Water Grace Products), Nashik

Fig. 8 Shredder at ((Water Grace Products), Nashik

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2. MATERIALS AND METHODOLOGY

We have planned the research work as per following steps.

1. To select the hospitals from different zones (Sharanpur Road, Panchavati, Ambad, Cidco, Nashik Road and Mumbai Octroy Naka and Categories them as per their specialization.
2. The authority letter to be taken from the principal of study center which is necessary to visit at respective hospitals.
3. We will explain our motto behind the research study.
4. With prior permission of respective hospital authorities, preliminary visit will be made with structured questionnaire.

Data Collection

In Nashik city, there are about 850 health care units. Out of which I had visited fifty seven hospitals. Survey was done by stratified sampling method i.e. from each zone, one hospital of each specialization was selected. The data was also collected from Civil hospital, Nashik Municipal Corporations hospitals, Charitable hospitals as well as Non-Government Organization (NGO) hospital. I was also specially visited to Common Biomedical waste treatment facility (Water Grace Products).

A visit was made with structured questionnaire and the necessary data was collected from each hospital regarding source of waste generation, types of waste, waste collection and segregation methods, method of disposal and treatment techniques, bed strength, waste volume, monthly cost for disposal etc. After filling questionnaire a sign and seal was taken by the authorities of each hospital.

Besides this, I had also interviewed the staff members (authorities, medical officers, nurses, workers etc.) with regard to the general functioning and biomedical waste management. I had clicked few photographs from hospitals as well as common biomedical treatment facility in order to support our visit. I have observed curiously about the presence and use of colour coded bags, personal protective equipments, needle destroyer, sharp containers, autoclave, method of disposal and treatments. I had also enquired about the necessary training to be given to their staff. After making a survey I got fascinating results regarding the whole biomedical waste management which is carried out in different hospitals.

Sample Survey

Fifty seven Hospitals out of which three government, eleven general, eight gynecology, six pediatric, five orthopedic, six cardiology, four cancer and fourteen (ENT/Dental.Opthalm) , hospital had selected as a sample from different zones as per their specialization .Apart from these I also specially visited to Civil hospital, Non-government organization hospital, hospitals of Nashik municipal corporation (NMC).A visit to each hospital was made with structured questionnaire and information was collected about hospital waste management in each hospital.

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3. RESULTS AND DISCUSSION

Results are obtained after analysis of data, for this; tabular data are analyzed by graphical as well as statistical techniques. Data is also analyzed on the basis of actual observations after visiting various hospitals of each specialization.

Statistical Analysis

Chi square (χ^2) test by using 2 x 2 contingency table.

In this method data are arranged in table in such a way that table contains two rows and two columns which precise the distribution of two categorical variables. This test is applicable to find a relation between two variables .The responses are in the form of Yes/No. (Dixit J. V., 2017).Thus, hospitals are categorized as 1) Government and general hospitals 2) Private hospitals with specialization. This method is used to test association of type of hospital and norms followed by hospitals which are framed by Government. Formula used for calculation at the degree of freedom (df) 1 at

$$\chi^2 = (ad-bc)^2 N / (a+b)(c+d)(a+c)(b+d) \sim \chi^2_{(r-1)(c-1)}$$

Table 5.1a: Chi square (χ^2) test for type of hospital and use of colour coded bags.

Type of Hospitals	**Use of Colour coded bags**		**Total**
	Yes	**No**	
Government and General Hospitals	12 (a)	2 (b)	14
Private hospitals with specialization	37 (c)	6 (d)	43
Total	**49**	**8**	**57 (N)**

χ^2 calculated = 0.0009661 df = 1 P = 0.05%

The bio-medical waste should be segregated as per categories applicable. (Sharma A.K., 1998). The key to minimization and constructive management of biomedical waste is segregation (separation) and identification of the waste. The most appropriate way of identifying the categories of biomedical waste is by sorting the waste into colour coded plastic bags or containers. Majority of the hospitals (85%) are using colour coded bags for segregation while in few hospitals (15%) segregation is not done properly. In most of the hospitals only red and yellow coloured bags are used for collection.

Table 5.1b: Chi square (χ^2) test for type of hospital and use of Needle destroyer

Type of Hospitals	**Use of Needle destroyer**	**Total**

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	Yes	**No**	
Government and General Hospitals	3 (a)	11 (b)	14
Private hospitals with specialization	9 (c)	34 (d)	43
Total	**12**	**45**	**57 (N)**

χ^2 calculated = 0.00015 df = 1 P = 0.05 %

Table 5.1c: Chi square (χ^2) test for type of hospital and use of Sharp container

Type of Hospitals	**Use of Sharp container**		**Total**
	Yes	**No**	
Government and General Hospitals	2 (a)	12 (b)	14
Private hospitals with specialization	2 (c)	41 (d)	43
Total	**4**	**53**	**57 (N)**

χ^2 calculated = 1.50 df = 1 P = 0.05 %

Sharps, which include syringes and needles, have the highest disease transmission potential amongst all categories of medical waste. Almost 85% of sharp injuries are caused between their usage and subsequent disposal. More than 20% of those who handle them encounter 'stick' injuries. (Shiferaw Y., et al, 2012).However, majority of the hospitals (78.94%) have not purchased needle destroyer. It was noticed that only 7% of the hospitals are using sharp containers.

Table 5.1d: Chi square (χ^2) test for type of hospital and arrangement of training session.

Type of Hospitals	**Use of Arrangement of training session**		**Total**
	Yes	**No**	
Government and General Hospitals	3 (a)	11 (b)	14
Private hospitals with specialization	4 (c)	39 (d)	43
Total	**4**	**50**	**57 (N)**

χ^2 calculated = 1.44 df = 1 P = 0.05 %

Lack of awareness among the generators, untrained workers in health care establishments as well as in municipal corporations has been the main hurdle in the waste management system. Not a single hospital run well planned awareness and training programme for their workers, staff (Bhagawati G.et al., 2015). To increase an awareness regarding health hazards due to bio-medical waste, training sessions should be arranged for all staff but in most of the hospitals (87.71%) no special training is given to the workers regarding personal hygiene, safety

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measures, health hazards due to handling of biomedical waste and the use of personal protective equipments.

Table 5.1e: Chi square (χ^2) test for type of hospital and appointment of waste management committee.

Type of Hospitals	**Appointment of waste management committee**		**Total**
	Yes	**No**	
Government and General Hospitals	2 (a)	12 (b)	14
Private hospitals with specialization	3 (c)	40 (d)	43
Total	**5**	**52**	**57 (N)**

χ^2 calculated = 0.70 df = 1 P = 0.05 %

Since the biomedical waste rules have come into force in (1998-2000) lack of adequate, appropriate and frequent monitoring due to manpower and infrastructure constraints is one of the reason for a poor waste management system. Due to inadequate planning resulted in improper waste handling practices. Most of the health care establishments don't have a well-defined waste management system which affected the environmental quality (Choudhury Asif ; Slathia Deepika, 2014, Aymen Abd-ULSalam et al. ,2018). Waste management committee should be appointed by hospital authorities to take care regarding waste collection, segregation, storage and transportation of waste. The committee should carry out health programmes such as periodic checkup, health education and training for the workers with special reference to hazards due to handling of wastes. However, only 8.77% hospital authorities have appointed waste management committee.

Table 5.1f: Chi square (χ^2) test for type of hospital and daily waste collection.

Type of Hospitals	**Daily collection of waste**		**Total**
	Yes	**No**	
Government and General Hospitals	9 (a)	5 (b)	14
Private hospitals with specialization	25 (c)	18 (d)	43
Total	**34**	**23**	**57 (N)**

χ^2 calculated = 0.1657 df = 1 P = 0.05 %

According to BMW rules untreated biomedical waste shall not be kept stored beyond a period of 48 hours because; the numbers of microorganisms present in the waste are likely to increase during storage (Chintis, V. et al., 2004). In general microorganisms will multiply at a faster rate with increasing temperature and moisture content. Therefore, biomedical waste must be

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collected daily from hospitals and transport it to treatment facility to avoid potential emissions of pathogens during storage (Li, C.S.; Jenq, F.T., 1993). Although waste storage is risky, about 60% hospitals have daily waste collection and transport it to treatment facility.

Table 5.1g: Chi square (χ^2) test for type of hospital and use of hand gloves as Personal Protective Equipment.

Type of Hospitals	**Use of hand gloves**		**Total**
	Yes	**No**	
Government and General Hospitals	10 (a)	4 (b)	14
Private hospitals with specialization	28 (c)	15 (d)	43
Total	**38**	**19**	**57 (N)**

χ^2 calculated = 0.18 df = 1 P = 0.05 %

Table 5.1h: Chi square (χ^2) test for type of hospital and use of Mask as Personal Protective Equipment.

Type of Hospitals	**Use of Mask as PPE**		**Total**
	Yes	**No**	
Government and General Hospitals	11 (a)	3 (b)	14
Private hospitals with specialization	24 (c)	19 (d)	43
Total	**35**	**22**	**57 (N)**

χ^2 calculated = 2.12 df = 1 P = 0.05 %

Table 5.1i: Chi square (χ^2) test for type of hospital and use of Apron as Personal Protective Equipment

Type of Hospitals	**Use of Apron as PPE**		**Total**
	Yes	**No**	
Government and General Hospitals	11 (a)	3 (b)	14
Private hospitals with specialization	24 (c)	19 (d)	43
Total	**35**	**22**	**57 (N)**

χ^2 calculated = 0.50 df = 1 P = 0.05 %

Table 5.1j: Chi square (χ^2) test for type of hospital and use of gowns as Personal Protective Equipment

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Type of Hospitals	Use of gowns as PPE		Total
	Yes	No	
Government and General Hospitals	6 (a)	7 (b)	14
Private hospitals with specialization	23 (c)	20 (d)	43
Total	**29**	**28**	**57 (N)**

χ^2 calculated = 0.47 df = 1 P = 0.05 %

To avoid health hazards while handling wastes, use of personal protective equipments should be done sincerely. (Blenkham J.I., 2006).However, it is observed that in most of the hospitals the use of personal protective equipments by their staff was found unsatisfactory. The hand gloves (66.66%), Masks (61.40%), Footwear (100%) are the most frequently used Protective equipments during the work, while aprons (50.87%) and gowns (56.14%) are rarely used (56.14%) Unfortunately, the management has not supplied the protective equipments such as eye shield (0%) for their staff, which is necessary to avoid eye injury.

4. CONCLUSION

The statistical study of various biomedical waste management in hospitals has shed (thrown) some light on the prevalent practices in dealing with important issue of disposal of medical waste in healthcare units. Acceptance of the null hypothesis (H_0) which is, there is no association between type of hospital and all these variables was proven in all results . These two attributes are independent since calculated value of χ^2 is less than table value of χ^2 (3.84) at 5% level of significance in each result. The waste produces in course of health care activities carries a higher potential for infection and injury than any other type of waste. This waste if disposed of improperly, can pose even greater threat than the original diseases. This type of waste has bad effects on the environment by contaminating the land, air and water resources. Thus, appropriate management of health care waste is a crucial component of environmental health protection. Therefore, it should become an integral feature of health care services.

Suggestions

Environmental management system should be strongly promoted in all hospitals through awareness programmes, training, demonstration and projects. Introducing awareness programmes, education and training initiatives should cover all stakeholders concerned with medical waste management. There should be a proper budget allocation for this activity.

Effective use of mass communication should be done to create awareness among citizens. The private sectors should be encouraged to enter the waste management area to increase the capacity, effectiveness of the disposal and recycling of waste. Three R policy “Reduce, Reuse and Recover” should be framed. Manufacturers of medical supplies should be encouraged to supply products that have a smaller adverse effect on the environment. Practices related to non-disposal items such as stainless steel trays, ceramic mugs, non PVC plastic items, glassware in

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place of disposable items needs to be encouraged. The "polluter pay principal" should be applied to all healthcare units. (Basak Shilpy Rani, et al., 2019)

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