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HOSPITAL WASTE MANAGEMENT IN SYLHET CITY

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ABSTRACT

Hospital waste has not been got proper attention in Sylhet City Corporation (SCC), which is also very common for other cities of Bangladesh. Even the solid waste management system of SCC is not effective and adequate. The study encompasses on an in-depth analysis of the present condition of waste management system of selected Health Care Centers (HCCs) in SCC and an assessment has been performed for the improvement of hospital sanitation situation. It is observed that the average waste generation rate for hospitals and clinics (HCC-A) is 0.934 kg/bed/day, which is much higher than that (0.0414 kg/capita/day) for diagnostic center and out door clinics (HCC-B). The percentage of hazardous waste produced in the 'HCC-A' is 22.92 where as that for 'HCC-B' is 36.03. These portions of hazardous wastes require special attention. The remaining portions of waste can be easily disposed off into the municipal dustbin if they are carefully segregated. A color-coding system and storage container has been recommended for segregating HW effectively. The average generation rate (kg/bed/day) of HW of Sylhet city is close to that of Dhaka city, but much lower than that of developed countries like USA, Netherlands and France. However, the percentage of hazardous waste of SCC is close to Germany and Dhaka city but much higher than that of Netherlands, Sweden and lower than that of Denmark and USA.

Keywords: waste, waste management, hospital, health, care.

INTRODUCTION

Sylhet, the northeastern divisional city of Bangladesh, is located at 24º53′N latitude and 91º52′E longitude with an estimated population of 0.6 million and a high migration rate especially a population growth rate of 4% per annum (Rahman and Islam, 2000) in comparison to the annual average growth rate of 2.01% in Bangladesh (Ahmed, 1994). Considering the demand of this huge increasing population, rapid and mushrooming growth of private clinics/hospitals is observed in the recent years in Sylhet city. At present, about 96 nos. health care centers (HCCs) are available in Sylhet City that includes government hospital, private hospital, clinics, nursing homes, dental clinics, diagnostic center, blood bank, and only out door clinics (Civil Surgeon Office, 2003). But most of private HCCs are housed in renovated residential building and do not have the facilities for adequate waste management systems. The inadequate waste management systems in these HCCs are posing a severe threat to public health as well as to the environment.

Health care waste and their category:

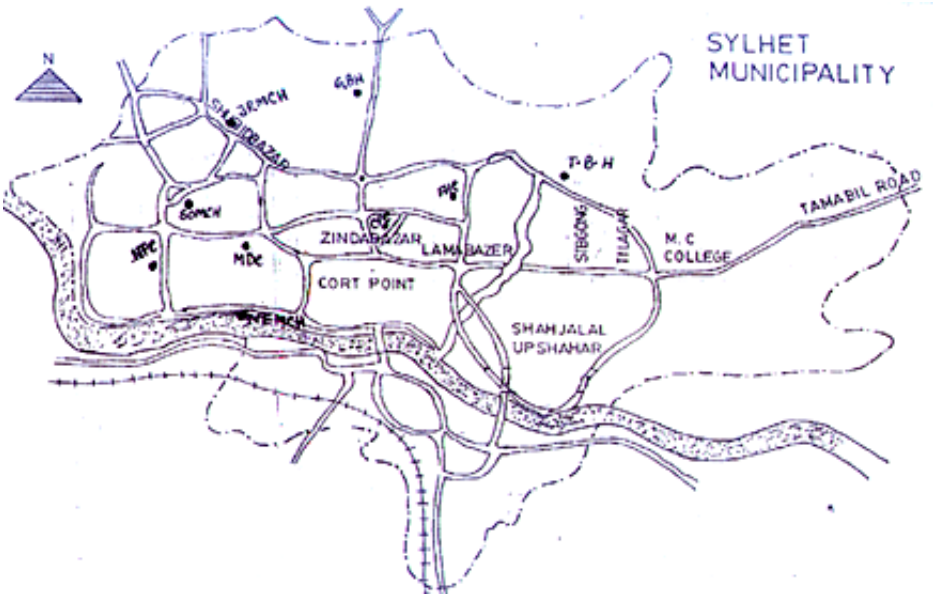
Hospital Waste (HW) includes all the waste generated by health-care establishments like hospitals, medical and biomedical research facilities, first-aid posts and sick bays, blood bank & collection centers, funeral and ambulance services, transfusion centers, mortuary and autopsy centers, biotechnology laboratories and institutions, Animal research and testing laboratories and also the waste arising from treatment in the home. Generally HW is categorized into infectious waste, pathological waste, pharmaceutical waste, chemical waste, genotoxic waste and radioactive waste. However, attempts have been taken to differentiate HWs broadly into two categories in this study such as Non-hazardous waste and Hazardous waste because personnel associated with waste management of HCCs can identify these wastes more easily.

Non-hazardous waste does not pose special handling problems to human health or environment. In this study, non-hazardous waste is classified into two categories such as general waste and reusable waste. General waste includes food waste, paper waste, non-infectious materials, waste originated from catering services and administrative establishment where as reusable waste includes ampoules, empty syrup bottles, barrel, plunger, empty saline bags and set without needles and nozzles that is not contaminated with blood or body fluid etc. On the other hand, hazardous waste is responsible for spreading of infectious and epidemic diseases and should pose special care in handling. In this study, hazardous waste is also classified into two categories such as clinical waste and sharp waste. Clinical waste includes blood bag, bloods contaminated saline/ set, blood and body fluid contaminated materials, body parts/organs, catheter, clothes used by AIDS and barrier's patients, drainage tube, gauge, bandage and cotton, surgical sponge etc. On the other hand, sharp waste includes BP blades, broken glass, cover slip, infusion set, knives, needles, nozzle of syringe, scalpels blades etc.

Selection of health care centers:

Among 96 Health Care Centers (HCCs) available in Sylhet City, 17 HCCs were selected for this study. Figure-1 shows the location of the selected HCCs.

Figure-1. Map showing the location of selected Health Care Centers (HCCs).



The following factors were considered for selecting Health Care Centers (HCCs):

- Type and rate of waste generation
- Size of Health Care Centers
- No. of hospital beds

Status of healthcare facilities:

All the selected HCCs were classified into two categories designated as 'HCC-A' and 'HCC-B' based on their services provided to the patients. All types of hospitals and clinics were categorized as 'HCC-A', where as all types of diagnostic center and only out door clinics were categorized as 'HCC-B'. All the surveyed HCCs ('HCC-A' and 'HCC-B') are summed up in Tables 1 and 2.

Table-1. List of surveyed hospitals or clinics (HCC-A).

S. #	Hospitals/Clinics	Notation	No. of beds	Category
1	Sylhet Osmani Medical College Hospital	SOMCH	510 (No. of patients is 1000)	Government
2	Jalalabad Ragib Rabeya Medical College Hospital	JRRMCH	250	Private
3	North East Medical College Hospital	NEMCH	250	Private
4	Sylhet Shahid Shamsuddin Hospital	SSSH	100	Government
5	General Shisu Hospital	GSH	75	Private
6	T.B.Hospital	TBH	56	Government
7	Noorjahan Hospital	NJH	45	Private
8	Niramoy Poly Clinic	NPC	39	Private
9	City Poly Clinic	CPC	30	Private
10	Gazi Burhanuddin Hospital Pvt.Ltd	GBHPL	27	Private
11	Ayesha Medicare	AM	25	Private
12	Central Hospital	CH	25	Private

Table-2. List of surveyed diagnostic centers or only out door clinics (HCC-B).

S. #	Diagnostic centers/ only out door clinics	Notation	Average No. of patients per day	Category
1	Marie Stopes	MS	44	NGO
2	Sylhet Samaj Kalyan Sangtha	SSKS	47	NGO
3	Family Heath Clinics	FHC	21	NGO
4	Reliance Diagnostic Center	RDC	36	Private
5	Modern Diagnostic Center	MDC	39	Private

MATERIALS AND METHODS

The Department of Civil and Environmental Engineering, Shahjalal University of Science and Technology, Sylhet conducted a study on the hospital waste management in Sylhet City. The study was conducted for the period of one year from July 2003 to June 2004. In this study preliminary survey, questionnaire survey, physical observation and survey for finding waste generation rates was conducted. The collected data and information were critically analyzed to assess existing waste management system, its limitation and impacts. An integrated management plan was recommended for efficient disposal of hospital waste.

RESULTS

Waste generation and comparison with different countries:

For finding out the generation rate of different categories of wastes, a weeklong survey at different hospitals, clinics, diagnostic center and outdoors clinics of SCC area has been carried out. The wastes were collected, weighed and recorded three times a day from each HCC. The timing was morning, noon and evening. The data collection survey for each HCC was a continuous program i.e. without break for weekend and general holidays. From analyses, it is observed that the average waste generation rate for 'HCC-A' (0.934 kg/bed/day) is much higher than that for 'HCC-B' (0.0414 kg/capita/day) as shown in Tables 3 and 4, respectively.

Table-3. Waste generation by 'HCC-A'.

S. #	Hospitals/Clinics	**Wastes**, kg/bed/day (% of total waste)		
		Total	**Non-hazardous**	**Hazardous**
1	SOMCH	1.80±0.097	1.401(77.81)	0.399(22.19)
2	JRRMCH	1.39±0.093	1.249(89.86)	0.141(10.14)
3	NEMCH	1.28±0.024	1.145(89.59)	0.133(10.41)
4	SSSH	1.54±0.242	1.21(78.57)	0.33(21.43)
5	GSH	0.55±0.043	0.445(80.91)	0.105(19.09)
6	TBH	0.22±0.03	0.16(72.73)	0.06(27.27)
7	NJH	1.047±0.11	0.777(74.21)	0.27(25.79)
8	NPC	0.873±0.053	0.633(72.51)	0.24(27.49)
9	CPC	0.84±0.168	0.622(74.05)	0.218(25.95)
10	GBHPL	0.2±0.016	0.137(68.50)	0.063(31.50)
11	AM	0.66±0.091	0.49(74.24)	0.17(25.76)
12	CH	0.803±0.062	0.58(72.23)	0.223(27.77)
	Sub Total	**11.21**	**8.65**	**2.56**
	Average	**0.934**	**0.72 (77.08)**	**0.214 (22.92)**

Table-4. Waste generation by 'HCC-B'.

S. #	Diagnostic Centers/only Outdoor Clinics	**Wastes**, kg/bed/day (% of total waste)		
		Total	**Non-hazardous**	**Hazardous**
1	MS	0.044±0.0163	0.028(63.64)	0.016(36.36)
2	SSKS	0.0184±0.093	0.0124(67.39)	0.006(32.61)
3	FHC	0.051±0.019	0.033(64.71)	0.018(35.29)
4	RDC	0.066±0.0163	0.036(54.55)	0.03(45.45)
5	MDC	0.0276±0.0268	0.0192(69.57)	0.0084(30.43)
	Sub Total	**0.207**	**0.132**	**0.075**
	Average	**0.0414**	**0.0264 (63.97)**	**0.01491 (36.03)**

In this study, non-hazardous waste was categorized into general and reusable waste, where as hazardous waste was categorized into clinical and sharp waste. The percentages of general, reusable, clinical and sharp waste are presented in Tables 5 and 6 for 'HCC-A' and 'HCC-B', respectively.

Table-5. Different categories of waste generation by 'HCC-A'.

S. #	Hospitals/ Clinics	**Non-hazardous** (% of total waste)		**Hazardous** (% of total waste)	
		General	**Reusable**	**Clinical**	**Sharp**
1	SOMCH	68.11	9.70	19.68	2.51
2	JRRMCH	78.24	11.62	7.64	2.5
3	NEMCH	77.52	12.07	6.85	3.56
4	SSSH	68.60	9.97	17.83	3.61
5	GSH	33.78	47.13	14.74	4.35
6	TBH	61.81	10.92	4.93	22.34
7	NJH	61.30	12.91	22.36	3.53
8	NPC	47.91	24.60	15.14	12.53
9	CPC	61.00	13.05	18.13	7.82
10	GBHPL	53.13	15.37	12.49	19.01
11	AM	60.8	13.44	22.06	3.7
12	CH	49.16	23.07	17.59	10.18
Average		**60.11**	**16.98**	**14.95**	**7.97**
Std. Deviation		**12.19**	**10.18**	**5.61**	**6.48**

Table-6. Different categories of waste generation by 'HCC-B'.

S. #	Hospitals/ Clinics	**Non-hazardous** (% of total waste)		**Hazardous** (% of total waste)	
		General	**Reusable**	**Clinical**	**Sharp**
1	MS	52.78	10.86	17.03	19.33
2	SSKS	44.46	22.93	15.91	16.70
3	FHC	53.23	11.48	6.69	28.61
4	RDC	34.53	20.03	24.75	20.69
5	MDC	44.28	25.29	14.56	15.87
Average		**45.86**	**18.12**	**15.79**	**20.24**
Std. Deviation		**6.86**	**5.92**	**5.76**	**4.53**

The percentage of non-hazardous waste produced in the 'HCC-A' was 77.08 among which the percentage of general and reusable waste was 60.11 and 16.99, respectively (Table-3 and 5). On the other hand, for the 'HCC-B' the percentage of non-hazardous waste was 63.98 among which the percentage of general and reusable waste was 45.86 and 18.12, respectively (Table-4 and 6). The percentage of hazardous waste produced in the 'HCC-A' is 22.92 among which the percentage of clinical and sharp waste is 14.95 and 7.97, respectively (Table-3 and 5). On the other hand, for the 'HCC-B' the percentage of hazardous waste was 36.03 among which the percentage of clinical and sharp waste was 15.79 and 20.24, respectively (Table-4 and 6). 'HCC-B' provides only out door services and diagnosis facilities, so the percentages of general waste is lower than that of 'HCC-A' (Table-5 and 6) that causes higher amount of hazardous waste produced by 'HCC-B' (36.03%) comparing to 'HCC-A' (22.92%) (Table-3 and 4).

The rate of waste generation differs due to geographical location, season of the year, collection frequency, availability of different treatment facilities, social status of the patient (i.e. income, living standard, awareness about diseases), hospital management, legislation etc. In middle and low-income countries, health-care waste generation is usually lower than that in high-income countries. Developing countries like Bangladesh are producing very small quantity of HW comparing to developed countries like United States of America. The average generation rate (kg/bed/day) of HW of Sylhet city is close to that of Dhaka city, but much lower than that of developed countries like USA, Netherlands and France etc. as shown in Figure-2. However, the percentages of hazardous waste of Sylhet city is close to Germany and Dhaka city but much higher than that of Netherlands, Sweden and lower than that of Denmark and USA as shown in Figure-3 (Rahman, et. al. 1999).

Figure-2. Comparison of generation of HW among different cities and countries.

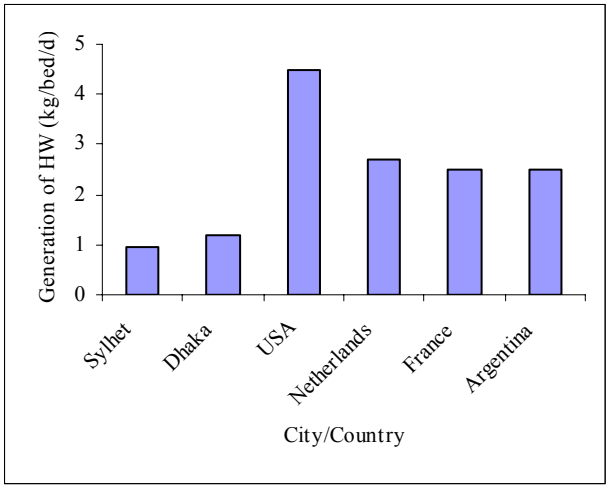
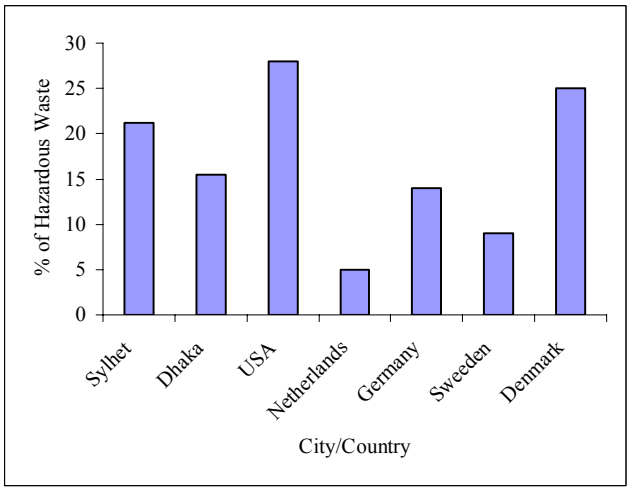


Figure-3. Comparison of hazardous waste among different cities and countries.



Existing HW management system of Sylhet city and its limitations:

Since Sylhet is not an industrialized city, the major sources of solid waste are residence, streets, market places, commercial establishments, hospital, clinics and diagnostic center etc. Hospital waste (HW) is an integrated part of the solid waste and a varying proportion of hospital waste (HW) requires special attention. Recent research findings state that in Sylhet City Corporation (SCC) approximately 288 tons of solid waste are generated every day and among them about 6 tons are hospital waste (Rahman, et al. 2003). It is observed that existing HW collection, handling and disposal practices of all the HCCs of SCC involved transport of wastes by ward boys, maid nurses and other employees from the point of generation to initial storage points in each unit. Wastes are normally collected from small bowl or plastic bin provided for each bed in HCC and stored either in a large size plastic bag or bucket (Figure-4). These plastic bags or wastes from buckets are then put in a pushcart and carried to the nearest municipal bins for dumping without any segregation or treatment (Figure-5). The municipal bins are normally placed either in hospital premises or outside the hospital. Wastes from operation theater, laboratory and hospital kitchen are also dumped into municipal bins (Figure-6). In some HCCs, HW has been seen to be dumped discretely at open places inside or just outside the hospital premises (Figure-7). SCC trucks carried these wastes three times daily to the landfill area for final dumping (Figure-8). Liquid wastes are disposed directly to the municipal sewer system in all of the HCCs in Sylhet city. A through monitoring showed that a moderate amount of HW is recycled manually by the scavengers from the bins or containers & from the final dumping site (Figure-9). The wastes that fall in this particular class are disposable syringes, plastic bags, glass, paper & bottles.

HWM is one of the most neglected parts of the managerial process in Bangladesh. Neither the government nor the hospital authorities pay proper attention to this matter (Rahman, et al. 1999). There are no well-defined rules and regulations of HWM in Sylhet City Corporation. That means no specific definition of HW and no specific and separate regulation for disposal of HW and also there is less priority for proper disposal of waste by the authorities and lack of accountability of concerned authorities. Since the existing solid waste management system of Sylhet City is neither satisfactory nor adequate and has been failed to keep pace with the vast amount of solid waste produced, the HW doesn't get proper attention (Rahman, et al. 2003). Again, for HCC in the poorer parts of Sylhet City, there is not enough information on HW management technologies & their impacts. By analyzing the organizational setup of different HCCs, it is observed that no person is directly responsible for disposal of HW. Hospital authorities tend to overlook the matter, as a proper system requires a large amount of money. As long as there is no authority to monitor it, they have no legal bindings to follow proper management practices of HW. There is no control on HWs after it gets out of the HCCs. Moreover people are not conscious of harmful effect of hazardous HW on environment. The majority of health care workers in SCC has only a basic understanding of health and do not perceive handling or disposal of HW as a hazard.

Figure-4. Photograph showing the storage system of waste generated in a govt. HCC bed.

Figure-5. Photograph showing the transportation of HW inside the hospital.

Figure-6. Photograph showing the dumping of HW in SCC bin.

Figure-7. Photograph showing the open dumping of HW in front of a HCC.

Figure-8. Photograph showing the open transportation of HW by collecting vehicle of SCC.

Figure-9. Photograph showing a scavenger collecting used blood bags and syringes dumped in front of a HCC.

Impact of present practices:

The present system of HWM in SCC is environmentally ineffective, inefficient and hazardous to health. No proper segregation has been practiced in HCCs. It was observed that, 77.08% of hospital waste is non hazardous and may be treated as general solid waste. Due to lack of proper segregation, this large portion of non-hazardous waste is unnecessarily polluted by hazardous

waste. Besides, there is no separate collection bin for hospital waste and all kinds of waste from hospitals including clinical and sharp wastes, is dumped in the municipal waste collection bins. This ill practice creates the possibility of contamination of whole mass of solid waste by infectious HW. Clinical waste contains both biodegradable and non-biodegradable polymers. There is no procedure for separation the non-biodegradable polymers form residues when the residues are dumped in a municipal landfill. The non-biodegradable portion create tremendous problem in municipal solid waste management. The microorganisms may create a cyst to survive in adverse condition and contaminate the environment. Liquid wastes produced from all HCCs are discharged directly into Municipal sewer lines. Chemical used in HCCs is a potential source of water pollution (WHO, 1983). Direct disposal of faces and urine of infectious patients in municipal sewer system may cause outbreak of epidemic diseases.

Open dumping of hospital waste has also been observed in some HCCs that create the possibility of contamination of soil, ground water, surface water and air. It creates public nuisance. It clogs sewers, drains, encroach roadways, diminishes landscape aesthetics and causes unpleasant odors. In an open dump, there is ready access of domestic animals to the hazardous waste and subsequently potential spread of disease and chemical contamination through the food chains. Besides, in some HCCs, HW has been burnt. When waste containing plastics is burnt, dioxin is produced which can cause cancer, birth defects, decreased psychomotor ability, hearing deficits, cognitive defects and behavioral alternations in infants.

Most of the municipal bins are not properly designed. Vectors like rodent, birds, flies etc. can enter the bins easily and scatter the wastes. Flies also sit on the uncovered piles of rotting garbage. These promote mechanical transmissions of fatal diseases like Diarrhea, Dysentery, Typhoid, Hepatitis, and Cholera. Under moist conditions, mosquito transmits many types of infections like Malaria and Yellow fever. Similarly dogs, cats, and rats also transmit a variety of diseases including Plague and Flea born fever, as they mostly live in and around the refuse. A high tendency of contracting intestinal, parasitic and skin diseases is found in workers engaged in collecting refuse. Surface run off directly from waste deposit in bins may contaminate surface water.

A large number of people depend on the recycling operation of solid and hospital waste in SCC area. People pick up used syringes from the HW and sell them. Many drug addicts reuse these syringes that can cause hepatitis, AIDS and other dangerous and contagious diseases. The scavengers engaged in recycling operation are extremely poor, do not have education, and unaware of harmful consequences of exposure of contaminated and hazardous waste (Rahman, 1996). They collect wastes from the street and dustbin for the desired material in bare hand without any protection and unaware of the nature of the materials present. Thus they are at risk from sharps, pharmaceuticals and chemicals and from direct contact with infectious materials. So scavengers involved in recycling face a high risk of silent epidemics of infectious diseases like viral hepatitis, typhoid, pneumonia, gangrene, AIDS etc. Also recycling of infectious objects may pose serious health hazard to their users.

If HW has not been managed properly it will be harmful to the environment. It not only poses a threat to the employees working in the hospital, but also to the people surrounding that area. Infectious waste can cause diseases like Hepatitis A & B, AIDS, Typhoid, Boils, etc. The lack of proper attention of HWM, could mean that the people around the health care establishments are also liable to be exposed to health hazards, as hazardous wastes are more often disposed off to the common waste bins designated to collect domestic waste. As a result, health care workers, patients, waste handlers, waste pickers & the general public are exposed to health risk from infectious wastes, chemicals & other HW.

Waste management plan for HCCs:

The management of HW requires its removal and disposal from the HCCs as hygienically and economically as possible, by methods that all stages minimize the risk to public health and to the environment. The basic concepts of waste management in a hospital do not differ basically from that in hotels, schools and catering establishments since certain areas of hospital render the same type of basic services. But some wastes generated in a hospital are too hazardous to be treated negligently, and any carelessness in the management of these wastes in a hospital tends to spread infections and contaminate the entire living environment prevailing in a hospital.

Table-3 and 4 revealed that the percentage of hazardous waste is 22.92 and 36.03 for 'HCC-A' and 'HCC-B', respectively. These portions of hazardous wastes require special attention. The remaining portions of waste can be easily disposed off into the municipal dustbin if they are carefully segregated. Thus a few changes in material procurement process in HCCs, mandatory staff education in waste segregation, proper hygiene education to the scavengers, treatment of selected hazardous materials, and such other few efforts can get HCC off the list of major hazardous materials to be disposed off to the municipal dust bins (Rahman et al, 1999). For performing segregation effectively the color-coding system aiming at ensuring an immediate and non-equivocal identification of the hazards associated with the type HW that is handled or treated can be used. In that respect, the color-coding system shall remain simple and be applied uniformly throughout the country. Table 7 represents a recommended color-coding system and storage container for segregating HW effectively. Once these are properly segregated; the hazardous portion can be treated by different treatment options (e.g. chemical disinfection, autoclaving, micro waving, incineration etc.). Any one of them or a combination of one or more of these options can be employed by different HCCs. An assessment of cost effectiveness of different treatment options (autoclaving, microwaving, incineration) indicates that the treatment of

hazardous waste in a centralized incinerator appears to be one of the best treatment options (Khan, 2004).

Table-7. Recommended color-coding for hospital waste.

Type of waste	Color of container and marking	Type of container
Clinical waste	Yellow	Strong, leak-proof plastic bag or container
Sharps waste	Red	Puncture-proof container
Reusable waste	Black	Leak-proof plastic bag or container
General waste	Green	Plastic bag or container

As large number of people depend on the recycling operation measures should be taken to minimize health hazards of the scavengers involved in recycling operations of HW. The health professionals involved in HCCs or in different authorities have societal responsibility to address this critical issue more carefully. Besides, different voluntary organizations could also participate to provide hygiene education to hospital staffs involved in waste management and also to the poor scavengers. The implementation of safe HWM procedures aims at reducing infections and thus reducing public health risks both within and outside the HCCs. The procedures should always contain the following measures:

- Minimization of the quantity of HW generated by the HCC.
- Segregation and identification of hazardous HW from non-risk HW.
- Adequate packaging and safe storage of the different HW.
- Proper treatment and disposal of hazardous and non-risk HW.

DISCUSSION

To improve overall HWM system in Bangladesh, it is indispensable that different authorities involved in HCC development and in monitoring and controlling the Bangladesh environment should recognize the nature of the problem for the development of legislation to regulate hospital sanitation. An improvement in HWM involves a number of activities, which can be undertaken as series of small steps on the road to improvement. There is no 'one stop' technical solution. Considering all situation and field observation there are some suggestions or recommendation for medical waste and infectious waste management:

Formulation and implementation of laws, regulation and guidelines:

There is the need of a national waste management policy and national waste disposal and management guideline for Bangladesh.

Public awareness:

Awareness building of hospital staff as well as the public about the harmfulness and proper handling of waste is necessary.

In-house management:

Considering the huge amount of municipal and industrial waste, which is generated, HW accounts for a small part of total solid waste. Infectious waste is merely 5% to 20% of total HW and is therefore minute when compared to the total amount of solid waste. Yet, proper identification and segregation of hazardous medical waste will reduce the health risks involved by a great sum. At different stage of disposal, groups of people are involved and they are exposed to it. So harmfulness could be minimized if it is properly segregated and handled. Therefore proper identification and segregation of infectious and hazardous HW may reduce the quantity of waste as well as the risk of disposal.

Institutional cooperation:

There must be cooperation between hospitals and clinics to handle waste properly.

Treatment technology for infectious waste:

Autoclaving could be used in small clinics and laboratories to disinfect; central incinerators are more useful, this will reduce air pollution and would be cost effective.

LIMITATIONS OF STUDY

The study was carried out in only a few selected government, non-government hospitals, clinics and diagnostic centers of Sylhet City mainly for HWM. Selected HCCs were considered and visited to quantify the hazardous and non-hazardous portion of HW generated in Sylhet. The rate of waste generation was known for a few selected HCCs. The seasonal variation of waste generation rate could not be considered due to lack of enough time. The radioactive wastes and radon gas emission from HCCs are not considered here, because no equipment was available to detect the presence and concentration of gas.

REFERENCES

Ahmed, M. F. 1994. Municipal waste management in Bangladesh with emphasis on recycling, Aspect of Solid waste management Bangladesh context, Ed. Mofizul Hoq and Mrs. H. Lechner, German Cultural Institute, Dhaka. pp.113-131.

Civil Surgeon Office. 2003. A report on Hospital Management. Civil Surgeon Office, Sylhet.

Khan, T. A. 2004. A study on hospital waste management in Sylhet city. B. Sc. Engg. Thesis. Department of Civil & Environmental Engineering, Shahjalal University of Science and Technology, Sylhet, Bangladesh.

Rahman, M. H. 1996. Hospital sanitation in Bangladesh. Proc. of 12th Int. conf. on solid waste management & Secon. Mats., USA.

Rahman, M. H., Ahmed, S. N. and Ullah, M. S. 1999. A study on hospital waste management in Dhaka City. 25th WEDC conference, Addis Ababa, Ethiopia. pp.342-345.

Rahman, G. and Islam, M. M. 2000. Urban growth pattern in Dhaka City and its problem of urban solid waste management. Bangladesh Environment 2000. Ed. M. Feroz Ahmed, Bangladesh Paribesh Andolon, Dhaka. pp. 436-443.

Rahman, M. T., Sarkar, M. S. K. A., Chowdhury, M. A. I., Haque, K. E. and Hasan, M. M. 2003. Solid waste pollution in Sylhet City, Bangladesh Journal of Environmental Science. Vol. 9(2): 297-303.

World Health Organization (WHO). 1983. Management of wastes from hospitals, World Health Organization, Regional Office for Europe, Copenhagen.