Bangladesh Journal of Environmental Research, Vol. 11, 55-66, 2020 *ISSN: 1996-8914*

Existing Scenario of Healthcare Waste Management in Noakhali, Bangladesh

Mustafizur Rahman[1], Protima Sarker[1], Nandita Sarker[2*]
[1]Department of Environmental Science and Disaster Management, Noakhali Science and Technology University, Sonapur-3814, Noakhali, Bangladesh
[2]Department of Environmental Sciences, Jahangirnagar University, Dhaka-1342, Bangladesh

(Received: 21 May 2020, Revised: 17 June 2020, Accepted: 21 June 2020, Online: 30 June 2020)

Abstract
Healthcare waste (HCW) has become one of the critical concerns in developing countries like Bangladesh. Since establishing a proper HCW management strategy requires practical information on current conditions, this study surveyed 72 hospitals and 37 diagnostic centres in Noakhali district, Bangladesh to identify the current HCW management status. Data were collected via questionnaire surveys, on-site observations and direct weighing of waste. The study approach involved the estimation of the quantity of HCW generated, evaluation of processes i.e. segregation, storage, packaging treatment, final disposal and determination of the knowledge of healthcare workers regarding HCW management. The rate of HCW generation was 1730.53 and 76.5 kg per day for hospitals and diagnostic centres, respectively. Hazardous waste covered 31% of the total waste generated. There was no adequate and appropriate HCW segregation, storage facilities in the majority of the facilities. Only three hospitals and one diagnostic centre used to manage their HCW according to the guideline provided by the World Health Organization. About 80.73% of healthcare facilities used to dispose of HCW, along with the general municipal waste without any treatment. Only 9% of the respondents received specific training in the management of HCW. Existing HCW management systems in Noakhali district require adequately formulated waste minimisation strategies, guidelines, implementation of legislation, and budgets. A mix of all required to protect the healthcare workers, community people and the environment from the adverse impact.

Keywords: Healthcare waste (HCW), Medical waste, Waste management, Segregation.

Introduction

Healthcare waste (HCW) management is a global issue. The World Health Organization (WHO) also regards healthcare wastes as special wastes regarding their potential to cause environmental hazards and risk to public health (Sawalem et al., 2009). Healthcare waste consists of all waste generated at healthcare facilities, medical research facilities, and laboratories including both non-hazardous and hazardous waste such as sharps (needles, blades), infectious (blood, bodily fluids), chemical, pharmaceutical, radioactive waste and pressurised container. Inadequate management of HCW can cause harm to humans through injury caused by sharp instruments, blood and other body liquids, infectious diseases such as HIV infection and hepatitis transmitted to humans due to proliferation of micro-organisms, pollution of the environment and groundwater contamination

*Corresponding Author (sarkernandita@juniv.edu)

Citation: Rahman, M. et al., 2020. Existing Scenario of Healthcare Waste Management in Noakhali, Bangladesh, Bangladesh Journal of Environmental Research, 11, 55-66.

(Diaz et al., 2005). The general public at risk of HCW includes staffs in waste collection and disposal centres who are directly exposed, hospital staff, visitors, tourists to hospital institutions, aid administrations workers, children, babies in mothers' bellies, individuals from the open and foragers (Oli et al., 2016). The World Health Organization estimated that each year there were about 8 to 16 million new cases of Hepatitis B virus (HBV), 2.3 to 4.7 million cases of Hepatitis C virus (HCV) and 80,000 to 160,000 cases of human immune deficiency virus (HIV) due to unsafe injections and mostly due to the indigent waste management system (Townend and Cheeseman, 2005). Although large portions of these wastes are classified as a non-hazardous household, waste posing no potential risk may be considered similar to household waste. It can be disposed of using the same methods. Only a small part is deemed to be hazardous and requires special attention for disposal, as these representing a potential threat if not disposed of appropriately. However, if this waste is mixed with non-hazardous waste, the whole waste stream should be disposed of in accordance with the Hazardous Waste Regulations. Costs will also increase substantially which is also an essential economic factor in healthcare facilities (Askarian et al., 2010). So, the management needs adequate sorting techniques to separate the hazardous fraction from the root and sort it into infectious and harmful sub-fractions to reduce their proportion (Graikos et al., 2010). Concerns regarding the potential problems caused by healthcare wastes are highlighted by a study of 22 developing countries with inappropriate waste disposal methods. The majority of problems are associated with exponential growth in the healthcare sector together with low- or non-compliance with guidelines and recommendations (WHO, 2004).

In developing countries like Bangladesh, there is a lack of awareness among health practitioners and the general public about the implications of inappropriate handling of HCW, the possible risk of environmental and public health hazards (WHO, 2018). Medical wastes account for a tiny fraction, about one per cent of the total solid wastes generated in Bangladesh (The World Bank, 2012). According to the Dhaka City Corporation's research report, 3700 metric tons of wastes are generated per day in Dhaka City and about 200 tons are hospitals waste of which 40 tons are infectious wastes. However, when this small amount is not handled properly, it gets mixed with domestic solid waste, and the whole waste stream becomes potentially hazardous(Hassan et al., 2008). It has been reported that most of the hospitals, except a few private hospitals, dispose of health care wastes along the roadsides as the solid and commercial wastes are disposed of (Biswas et al., 2011).

Noakhali district is in the south-eastern part of Bangladesh with a population of about 3108083 (Statistics, n.d.). The growing number of hospitals, clinics, and diagnostic centres in the Noakhali is an alarming issue due to lack of proper management practices. A comprehensive healthcare waste management (HCWM) plan must be implemented to protect the community people and the environment from the negative impact. Unfortunately, practical information on types, source, compositions of HCW and the medical waste generation rate, collection, transportation, treatment, and ultimate disposal is currently inadequate (Cheng et al., 2009). Information of the critical components including the size of the healthcare facility, inhabitance rate of hospital beds, medical waste segregation system, the area of a healthcare facility and the type of services provided are also inadequate (Tudor et al., 2005). In that context, the objective of this study was to analyse the

healthcare waste status, existing management practices and limitations regarding HCW waste management in hospitals and diagnostic centres in Noakhali district, Bangladesh.

Methodology

Study area

This study was carried out in the 72 Hospitals and 37 Diagnostic centres in Noakhali district (Figure 1) for 6 months period in 2018-19. About 61% of health care facilities are placed in Sadar Upazila because of its better transportation facilities and high population density, and the other 39% concentrated other eight Upazila in Noakhali.

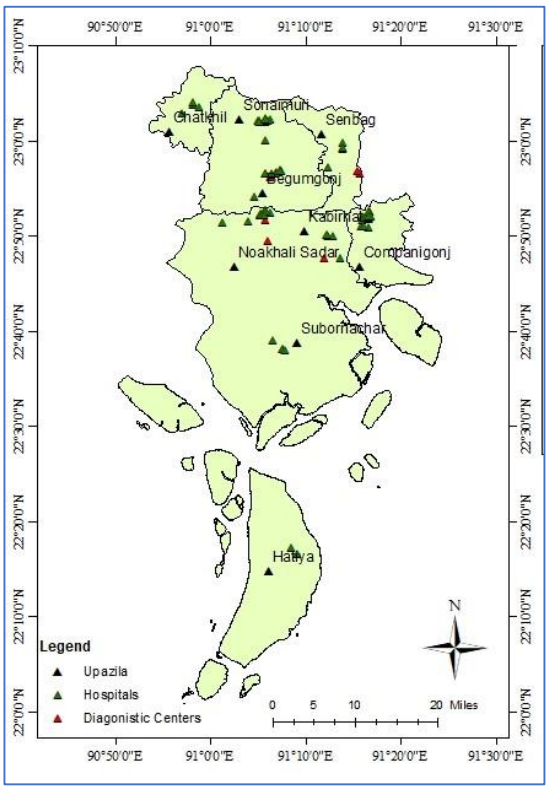

Figure 1: The study area with indicated sampled healthcare facilities.

Data collection

Data were collected from healthcare facilities (government and non-government hospitals, diagnostic centres) and other waste disposal operatives. The target populations of this study were employees directly or indirectly involved in patient care such as medical unit staff, laboratory staff, cleaning staff, and other support staff at official medical waste management. Individuals working for mortuary departments, transferring the waste from inside bins to roadside bins, waste collectors employed by Noakhali Pourosova to collect waste from roadside bins and to transport it to designated dumping places.

The data gathering techniques included observation, questionnaire survey and informal dialogue to examine the behaviours of workers and direct weighing the HCW waste. The questionnaires were formulated based on the modified methods of Townend and Cheeseman (2005) and UNEP/WHO (2005), to evaluate the knowledge and perception on waste management practices of housekeepers and HCW management workers. Questionnaires data were obtained from each source. Amount of wastes were obtained by weighting waste two times in a day and averaged weight over seven days while the type of waste was identified through direct observation. The wastes were classified according to UNEP/WHO, (2005).

Data Analysis

The quantity of waste generated from the sampled facilities was generalised to estimate HCW generation for the entire study area using the modified formula proposed by Patwary et al. (2009):

$$G_w = (T_{hb}W_{hb}) + (T_{dt}W_{dt})$$

Where, G_w is total waste generated per day; T_{hb} is the total number of hospital beds in Noakhali; W_{ta} is average waste per hospital bed per day in sampled hospitals; T_{dt} is the total number of diagnostic centres services beneficiary per day in Noakhali and W_{dt} is average waste per diagnostic services beneficiary in sampled diagnostic centres. The data were recorded and analysed using Microsoft Excel.

Results and Discussion

Estimation of total HCW generated

A representative sampling plan had been adopted for this study with the aim of obtaining the result to provide an accurate estimate of the overall rate of HCW generation in Noakhali district. The total rate of healthcare waste production in Noakhali district was 1807.03 kg per day (Table 1). Whereas, the rate was 1730.53 kg per day for hospitals and 76.5 kg per day for diagnostic centres. In Dhaka city, this rate was 13.6 ton per day given in a JICA report (JICA, 2004). On the other hand, 31% of the total waste generated was classified as hazardous. This is generally higher than the range found in a study by WHO (2001) on the composition of medical waste, where 10–25% of waste from HCFs was found to be hazardous. The variation between hospitals and diagnostic centres is due to admission facilities for patients.

The average HCW generation rate was around 0.45 kg/bed/day (Table 1) which was higher than the average waste generation rate in Bangladesh (0.25 kg/bed/day) founded by Patwary et al. (2011). The economic, social, cultural status of patients, number of beds, types of health services, and the general condition of the area where the hospital is located affects the amount of waste generated from hospitals (Maamari et al., 2015). In Greece, the HCW generation rate was of 1.4 kg/bed/day (Tsakona et al., 2007).

Table 1: Summary of HCW generated by the healthcare facilities surveyed in Noakhali

Healthcare facilities	Rate of medical waste generation (kg/day)	The average waste generation rate	Hazardous waste (%)	General waste (%)
Hospitals	1,730.53	0.45 kg/bed/day	23	77
Diagnostic centre	76.5	0.1996 kg/patient/day	39	61
Total	1807.03		31	69

There is only one hospital (government) with more than 100 beds in Noakhali with average waste generation rate of 0.52 kg/bed/day. Average waste generation rate was higher than the hospitals with lower beds (i.e. having 100 beds or less). Also, the average waste generation rate of the two government hospitals (<30 to ≥50 beds) included in the survey was higher than the two private hospitals. These may be due to, a large number of patients visit these government hospitals for their cheap health care facilities than private hospitals. Private hospitals with small bed number (i.e. having less than 20 beds) had average waste generation rate of 50 kg/bed/day which was much higher than the average waste generation rate of both government and private hospitals with 20 to 100 beds. There is a higher likelihood in larger institutions that any waste will leave a department without being weighed. At the same time, in smaller establishments, there might be a movement of waste between departments until it is weighed.

Table 2: Average HCW generation rate for each hospital category in Noakhali

Hospital categories	Number of hospitals		Average waste generation rate (kg/bed/day)	
	Government	Private	Government	Private
A: ≥20 beds	0	17	-	0.50
B: <20 to ≥30 beds	0	7	-	0.38
C: <30 to ≥50 beds	2	26	0.4	0.35
D: <50 to ≥100 beds	6	13	0.48	0.35
E: <100 beds	1	0	0.52	-

Types, sources and composition of HCW

Various parameters, such as the size of the healthcare facility, the type of patient care provided and the waste segregation system determine the composition of medical waste. This composition of wastes also varies among different sections of the health care facility (Tudor et al., 2005). Table 3 depicts the classification of HCW generated in different sections of healthcare facilities in Noakhali district (UNEP)/SBC and (WHO) (2005). According to this classification, sources of HCW requiring special attention (type B) were mainly, doctor's chamber, patient service/word, laboratories, operation theatres, receiving and emergency, outpatient clinics and ICU. Housekeeping, doctor's chamber, patient service/word, laboratories, operation theatres, receiving and emergency, blood bank and ICU were more likely to generate Infectious and highly infectious wastes (type C).

Table 3: Types and sources of HCW generated in healthcare facilities in Noakhali

Source of waste	Classification code	Types of waste	Quantity (kg/day)	Percent age
Administrative	A1	Paper box, paper (mixed), metal (can and aluminium), non-plastic packaging	76.61	4.24
	A2	Food waste.		
	A3	Plastic, rubber		

Source of waste	Classification code	Types of waste	Quantity (kg/day)	Percent age
Housekeeping	A1	Towel, blankets	29.09	1.61
	A3	Soap, spray can		
	C1	Grey water		
	C2	Pest control		
	D	Bulbs		
Laundry	A1	Papers	7.77	0.43
	A3	Detergents packets, liquid waste		
Kitchen	A2	Vegetables, fruit waste, eggshells, bones	808.81	44.76
	A3	Coffee filter bag, slaughter waste, food packaging		
Hospital compound	A1	Tissue, leftovers, papers	52.76	2.92
	A3	Coffee cup, plastic bottle, straw		
Doctors chamber	A1	Papers	8.31	0.46
	B2	Sharp waste		
	B3	Pharmaceuticals		
	C2	Syringe		
Patient service/word	A1	Textile	355.44	19.67
	A2	Food waste,		
	A3	Liquid, plastics bag		
	B1	Bodily fluids		
	B33	Pharmaceuticals		
	C1	Bandage		
	C2	Blood bag, used gauge, needles		
Laboratories	A3	Metals (mercury in broken thermometer), batteries	50.6	2.80
	B4	Solvents, reagents, disinfectants		
	C2	Cultures, used swabs,		
	D	Disposable medical devices, sterilises		
Operation theatres	B1	Organs	97.4	5.39
	B3	Pharmaceuticals		
	B33	Scalpels and blades, syringes		
	B5	Fluids, body parts		
	C2	Human tissues		
Receiving and emergency	A1	Tissue paper	26.2	1.45
	A3	Plastic bag		
	B3	Pharmaceuticals		
	C2	Used gauge, bandage and syringe		
Disinfecting activities	A3	Bottle, spray, mask, gloves	114.6	6.34
	B4	Chemicals		
Blood bank	A3	Plastics	16.98	0.94
	C2	Used blood bag, syringe, slides		
Pharmacy	A1	Packaging	75.53	4.18
	A3	Plastics		
	B31	Expired drugs		
Quarantine	A1	Packaging material	2.71	0.15
	A2	Food waste		

Source of waste	Classification code	Types of waste	Quantity (kg/day)	Percentage
Out-patient clinics	A1	Packaging material	77.9	4.31
	A2	Food waste, papers		
	B31	Expired drugs		
ICU*	C1	Saline bag	6.32	0.35
	C2	Blood bag, Used syringe		
	B3	Medicine packets		
	E	Radioactive substance, X-ray paper		

*ICU facilities in all private healthcare are not available in every Upazila except Sadar Upazila of Noakhali district. Public healthcare has ICU facilities but those are not fully functional.

Healthcare Waste: **A:** Non-risk HCW (**A1:** Recyclable waste; **A2**: Biodegradable waste; **A3:** other non-risk waste); **B:** HCW requiring special attention (**B1:** Human anatomical waste; **B2**: Sharps; **B3:** Pharmaceutical waste (**B31:** Non-hazardous Pharmaceutical waste; **B32:** Potentially hazardous Pharmaceutical waste; **B33:** Hazardous Pharmaceutical waste); **B4:** Cyto-toxic Pharmaceutical waste; B5: Blood and body fluids); **C:** Infectious and highly infectious waste (**C1**: Infectious waste; **C2:** Highly Infectious waste); **D:** Other hazardous waste; **E:** Radioactive waste (UNEP/SBC and WHO (2005)).

About 44.76% of total waste corresponded to kitchen waste which are non-risk HCW (type A). These wastes were mostly non-hazardous unless it becomes blended with hazardous waste. These also imply that good segregation practice from the source is required to ensure a reduction in the quantity of hazardous medical waste which is more expensive to manage. The proportion of waste from kitchens is higher than previously observed (28%) in the HCEs in the northern part of Jordan (Bdour et al., 2007). Figure 2 (A, B) present the composition of general waste and hazardous waste generated in healthcare facilities in Noakhali. The highest percentage of general waste was also covered by food wastes. Among the hazardous waste, 47% was infectious waste. The wastes generated from the treatment of infectious diseases affected patients may spread infection either through direct contact or indirectly through the environment.

Status of collection, segregation, storage, treatment and disposal of HCW

Medical facilities in different upazila of Noakhali are characterised by inadequate and inappropriate HCW collection services, lack of storage facilities, improper disposal methods and inadequate and inappropriate protective gear for HCW handlers. According to the survey, the waste van of Noakhali Pourosova had been collecting waste from hospitals more than once per day (Table 4). Because of their lower waste generation rate than hospitals, HCW from all the diagnostic centres were collected once per day. None of the surveyed healthcare facilities had any temporary waste storage facility for segregation of waste. Hospitals store waste behind their buildings. Segregation of hazardous waste and non-hazardous waste prior to disposal is prerequisite of a proper health care waste management system. World Health Organization recommends the segregation of HCW at the source of generation and provides guidelines for the safe and sound management of HCW in developing countries (WHO, 1995). Sixty-six hospitals and thirty-five diagnostic centres had been practising segregation of a solid and liquid portion of wastes. Segregation practice of hazardous waste for treatment and disposal was also absent in 95.41% healthcare facilities. From this study, it is evident that the WHO guidelines had not been followed in the HCW management of the

hospital. Wastes were carried using plastic boxes or containers, which pose a threat to the staffs collecting wastes due to glass and sharp waste in stored waste.

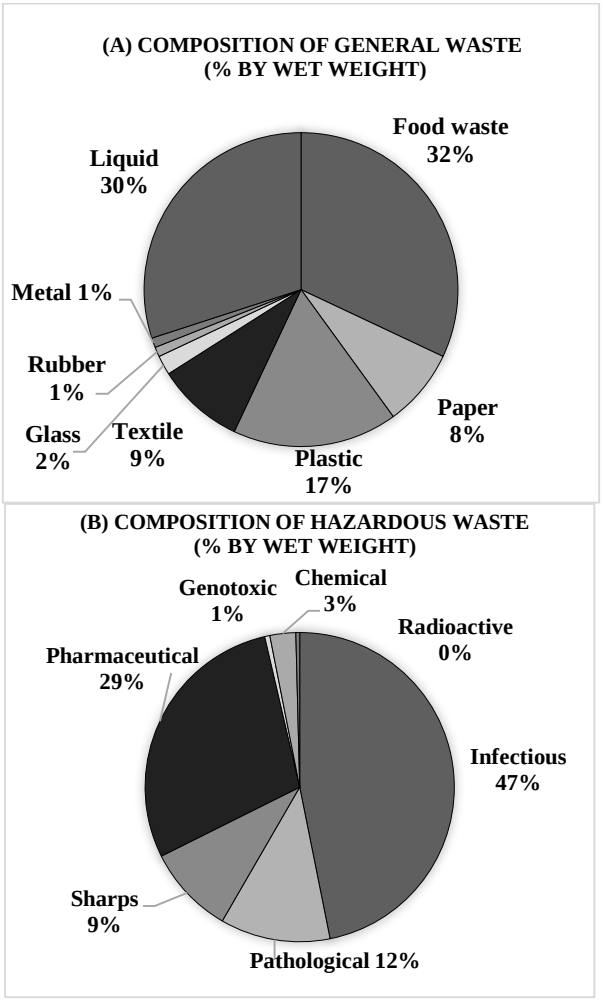

Figure 2: Composition of **(A)** general waste and **(B)** hazardous waste generated in healthcare facilities in Noakhali.

Table 4: HCW collection, segregation and treatment facilities in Noakhali

Issues	Options	Hospitals	Diagnostic centers	% of total HCF
Waste collection per day	Once	0	37	33.9
	Two times	50	0	45.9
	Three times	22	0	20.2
Temporary waste storage	Yes	0	0	0
	No	72	37	100

Issues	Options	Hospitals	Diagnostic centers	% of total HCF
Segregation of liquid and solid waste	Yes	66	35	92.7
	No	6	2	7.3
Segregation of Hazardous and Non-hazardous waste	Yes	3	2	4.5
	No	69	35	95.41
Fate of liquid waste	Sewer	32	35	61.5
	Nearby water body	40	2	38.5
Packaging used for waste dumping	Plastic bag/ container	72	37	100
	Cardboard box/container	0	0	0
	Metal container	0	0	0
Fate of solid waste	Community dustbin	47	36	76.16
	Incineration	3	1	3.6
	Open Burning	16	0	14.7
	Burying in the ground	6	0	5.5

Table 5 is showing the status of solid medical waste dumping practice in Noakhali. Among 72 hospitals only 3 of them and among 37 diagnostic centres, only 1 had been following the guideline provided by WHO for waste disposal. Twenty-two hospitals had been disposing of their waste without any compliance with the guideline. The consequences of this practice extend to the possibility of polluting both surface water and groundwater resources in the vicinity of the dumpsite. In Noakhali, waste materials from health, clinics, and medical care services were still dumped in the dustbin provided by Noakhali Pourosova along with general household waste, even when the wastes are hazardous. This accounts for 76.16% of healthcare facilities (Table 4). Open burning waste was done by 14.7% of the healthcare for minimising quantity. Only three hospitals and one diagnostic centre had been practising incineration of hazardous waste but incinerator plants were not used frequently due to the lack of a suitable operative and reduce electricity cost.

Table 5: HCW disposal practice status in the surveyed healthcare facilities in in Noakhali.

Healthcare Facilities	Disposal		
	Proper*	Partial**	Without***
Hospitals	3	22	47
Diagnostic Centers	1	0	36
Total	4 (3.67%)	19 (17.43 %)	88 (80.73 %)

*****Proper: disposal according to medical waste management guide (WHO, 2004) through NGO
**Partial: disposal of waste, but without proper guidance;
***Without: disposal along with the general municipal waste.

Training and knowledge of HCW workers

Figure 3 is showing the status of training and knowledge of workers handling wastes. Status of training and knowledge of workers handling wastes regarding HCW management clearly reflects the HCW management receive less priority from the authority instead of its huge negative public health impact potential. Among 64 respondents, only 70% understood the importance of HCW management in the provision of safety to the public. The proportion of respondents received training on HCW management is 9%. None of the respondents knew the focal person responsible for HCW management in their hospital.

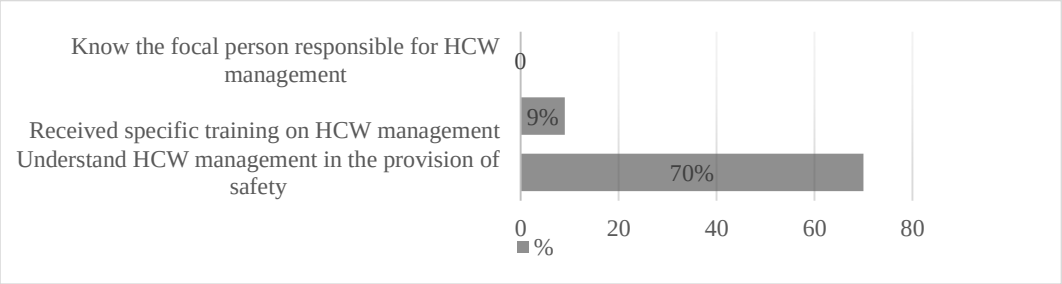

Figure 3: Training and knowledge of staffs handling HCW.

Conclusions

Waste management should be a priority issue amongst competing needs in the healthcare facilities. About 82% of healthcare facilities have monthly investment and budget for healthcare waste management but they cannot use it properly due to the lack of trained personnel, sufficient knowledge, and law enforcement. Due to their inadequate waste handling capacity and improper disposal, hospitals in Noakhali often receive many complains from patients, hospital staffs, Department of Environment (DoE), municipal authority and local communities about their existing practices. Collaboration among municipal authority, Department of Environment (DoE) and healthcare providers are necessary to develop a new and modern approach to deal with the medical waste properly to ensure health safety of patients, general people and employee engaged in HCW management.

Waste reduction through segregation at the source of generation should be performed. Colour-coded waste receptacles can be used according to WHO recommendation such as, red for highly infectious waste, yellow for other infectious waste, yellow-marked 'SHARPS' for sharp waste, brown for pharmaceutical waste, the lead box labelled with a radioactive symbol for radioactive waste and black for general or non-infectious waste—in addition to the colour coding, providing individual sharp proof containers for sharps waste. The hazardous component should be disinfected or autoclaved. Although, incineration has the advantage of being able to handle most types of medical waste and of achieving volume reduction. As these technologies are costly, using a central incinerator equipped air pollution control equipment (APC) can reduce the burden on both the

hospitals and the environment. It is also critically important to have professionally trained personnel to operate it. Specific materials should be reused and recycled. However, specific healthcare waste management guidelines should be provided and government regulations should be implemented along with continuous monitoring, research, and development.

Acknowledgements
The authors acknowledge financial support from the Department of Environmental Science and Disaster Management, Noakhali Science and Technology University. PRISM Bangladesh, for helpful support during data collection in the study area.

References

Askarian, M., Heidarpoor, P., and Assadian, O., 2010. A total quality management approach to healthcare waste management in Namazi Hospital, Iran. Waste Management, *30*(11), 2321–2326. https://doi.org/10.1016/j.wasman.2010.06.020

Bdour, A., Altrabsheh, B., Hadadin, N., Al-Shareif, M., 2007. Assessment of medical wastes management practice. A case study of the northern part of Jordan. Waste Management, 24, 746–759.

Biswas, A., Amanullah, A., and Santra, S., 2011. Medical waste management in the tertiary hospitals of Bangladesh: an empirical enquiry. ASA Univ Rev, *5*(2), 10.

Cheng, Y.W., Sung, F.C., Yang, Y., Lo, Y.H., Chung, Y.T., and Li, K.C., 2009. Medical waste production at hospitals and associated factors. Waste Management, 29(1), 440–444. https://doi.org/10.1016/j.wasman.2008.01.014

Diaz, L.F., Savage, G.M., and Eggerth, L.L., 2005. Alternatives for the treatment and disposal of healthcare wastes in developing countries. Waste Management, *25*, 626–637. https://doi.org/10.1016/j.wasman.2005.01.005

Graikos, A., Voudrias, E., Papazachariou, A., Iosifidis, N., Kalpakidou, M., 2010. Composition and production rate of medical waste from a small producer in Greece. Waste Manage. 30 (8–9), 1683–1689.

Hassan, M.M., Ahmed, S.A., Rahman, K.A., and Biswas, T.K., 2008. Pattern of medical waste management: Existing scenario in Dhaka City, Bangladesh. BMC Public Health, *8*, 1–10. https://doi.org/10.1186/1471-2458-8-36

Japan International Cooperation Agency (JICA), 2004. Clean Dhaka Master Plan, The Study on Solid Waste Management in Dhaka City, Progress Report, vol. 1.

Maamari, O., Brandam, C., Lteif, R., and Salameh, D., 2015. Health Care Waste generation rates and patterns: The case of Lebanon. Waste Management, 43, 550–554. https://doi.org/10.1016/j.wasman.2015.05.005

Oli, A.N., Ekejindu, C.C., Adje, D.U., Ezeobi, I., Ejiofor, O.S., Ibeh, C.C., and Ubajaka, C.F., 2016. Healthcare waste management in selected government and private hospitals in Southeast Nigeria. Asian Pacific Journal of Tropical Biomedicine, 6(1), 84–89. https://doi.org/10.1016/j.apjtb.2015.09.019

Patwary, M.A., O'Hare, W.T., and Sarker, M.H., 2011. Assessment of occupational and environmental safety associated with medical waste disposal in developing countries: A qualitative approach. Safety Science, 49(8–9), 1200–1207. https://doi.org/10.1016/j.ssci.2011.04.001

Patwary, M.A., O'Hare, W.T., Street, G., Maudood Elahi, K., Hossain, S.S., and Sarker, M.H., 2009. Quantitative assessment of medical waste generation in the capital city of Bangladesh. Waste Management, 29(8), 2392–2397. https://doi.org/10.1016/j.wasman.2009.03.021

Sawalem, M., Selic, E., and Herbell, J.-D., 2009. Hospital waste management in Libya: a case study. Waste Management 29, 1370–1375.
Statistics, O.F., (n.d.). Statistical Pocketbook Bangladesh, 2015. Bangladesh Bureau of Statistics (BBS).
The World Bank. 2012. Mainstreaming environmental management in the health care sector: Implementation experience in India and A Tool-kit for Managers. I and II, 1–168.
Townend, W. K., and Cheeseman, C.R., 2005. Guidelines for the evaluation and assessment of the sustainable use of resources and of wastes management at healthcare facilities. Waste Management and Research, 23(5), 398–408. https://doi.org/10.1177/0734242X05057764
Tsakona, M., Anagnostopoulou, E., and Gidarakos, E., 2007. Hospital waste management and toxicity evaluation: a case study. Waste Management 27 (7), 912–920
Tudor, T.L., Noonan, C.L., and Jenkin, L.E.T., 2005. Healthcare waste management: A case study from the National Health Service in Cornwall, United Kingdom. Waste Management, 25(6), 606–615. SPEC. ISS.), 606–615. https://doi.org/10.1016/j.wasman.2004.10.004
United Nations Environment Programme (UNEP)/SBC, and World Health Organization (WHO). 2005. Preparation of national healthcare waste management plans in Sub-Saharan countries: Guidance manual. http://www.who.int/water_sanitation_health/medicalwaste/en/guidancemanual.pdf
WHO, 1995. Suggested guiding principles and practices for the sound management of hazardous hospital wastes. SEA-EH-531. WHO Regional office for South-East Asia, New Delhi.
WHO, 2001. Healthcare waste management: rapid assessment tool for country level. Geneva, World Health Organization.
WHO, 2004. Safe Healthcare waste management: Policy paper. World Health Organization, Geneva.
WHO, 2018. Module 17 : Management of specific infectious wastes module overview.