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Healthcare Waste Management Practices in Bangladesh: A Case Study in Dhaka City, Bangladesh

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***Abstract*—**Healthcare waste (HCW) is one of the major concerns in environmental issues due to its infectious and hazardous nature that is requires specific treatment and systematic management prior to final disposal. This study aimed to assess HCW management system in Dhaka City (DC), Bangladesh, by investigating the present practices implemented by the city. In this study, five different healthcare establishments were selected in DC. Field visits and interviews with health personnel and staff who are concerned with the waste management were conducted. The information was gathered through questionnaire focus on the different aspect of HCW management like, waste segregation and collection, storage and transport, awareness as well. The results showed that a total of 7,215 kg/day (7.2 ton/day) of waste were generated, of which 79.36% (5.6 ton/day) was non-hazardous waste and 20.6% (1.5 ton/day) was hazardous waste. The rate of waste generation in these healthcare establishments (HCEs) was 2.6 kg/bed/day. There was no appropriate and systematic management of HCWs except at few private HCEs that segregate their hazardous waste. All the surveyed HCEs dumped their HCW together with the municipal waste, and some staff members were also found to be engaged in improper handling of the generated waste. Furthermore, the used sharp instruments, saline bags, blood bags and test tubes were collected for resale or reuse. Nevertheless, the lack of awareness, appropriate policy, regulation and willingness to act, were responsible for the improper management of HCW in DC. There was lack of practical training of concerned healthcare to handle the waste properly, while the nurses and staff were found to be aware of the health impacts of HCW.

***Keywords*—**Awareness, disposal, Dhaka City, healthcare waste management, waste generation.

I. Introduction

HEALTHCARE waste includes all the waste generated by HCEs, research centers and laboratories that is associated to health procedures. The waste produced by HCEs is comparable to domestic waste and usually regarded as general HCW or as non-hazardous waste. In addition, hazardous waste includes sharp, infectious waste, pharmaceutical waste, pathological and genotoxic waste, pressurized containers and high heavy metal and radioactive waste as well, which has the potential to pose a variety of environmental and health risks [1]. HCW is a special type of waste because it poses potential risks to either human beings or to the natural environment on direct or indirect contact [2]. Almost 80% to 90% of all waste produced by the HCEs are general or non-hazardous waste and is comparable to domestic waste. The remaining 10-20% of waste is considered as hazardous, and may pose a variety of serious human and environmental health risks [3]. Improper HCW management may cause inevitable human health problem and environmental pollution, unpleasant odors, and growth of insects, rodent, and worms; which may lead to transmission of various diseases like cholera, typhoid and hepatitis through injuries from sharps contaminated with human blood [2]. In recent decades, the management of the HCW is an evolving issue due to the lack of proper resources like training, awareness, and finance to support solutions [4]. Further, the public concern has been stirred in regard to whole systems such as generation, in-house storage, transportation, treatment, and disposal of HCW including infectious and toxic materials [5]. Appropriate management systems for handling and safe disposal of HCW are of great importance, which may minimize the risk to both public health and the environment.

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II. HCW Management in Bangladesh

HCW management is now an important agenda throughout the world both in developed and developing countries. To achieve appropriate HCW management, which is environmentally friendly as well economically viable for every country especially for developing countries where it is now a primary concern [6]. HCW produced in developing countries has raised serious concerns because of the inappropriate treatment and disposal practices [7]. Many researchers have studied HCW management in developing countries like Liberia [8], China [9], Ethiopia [10], Egypt [11], India [12], Turkey [13], Brazil [14], Ghana [15], Libya [16] and Bangladesh [17]. The results of these studies show that the management of HCW is poor and has not received adequate attention. On the contrary, in developed countries, some suitable and modern technologies like incineration, autoclaving and microwave are used for the proper treatment and final disposal of medical waste [18]. These methods can minimize the risks to health and the environment [19]. For example, in Jordan only 48% of hospitals used incineration for solid medical waste treatment [4], while in Brazil, 39.8% of waste is treated by incineration and 14.5% by autoclave [14]. China has an expensive medical waste disposal system costing 580 US$/ton, which is based on incineration technology [2], while in Iran, only one hospital used autoclave for treatment of infectious waste and has a capacity of not more than 40 liters per day [20].

In many developed countries, specific rules and regulations have been implemented for HCW management systems which are more effective than many developing countries [2]. The existing federal regulations, such as the law of Healthcare Waste Management in Brazil [14], the Ministry of Health (MoH) regulations in Jordan [4], the Medical Waste Control Act 380 in China, [2], and the Medical Waste Control Regulation (MWCR) in Turkey [13], are not implemented properly. While in Cameroon [21] and Ghana [15] there is lack of sustainable health care waste management legislation and policy. However, the lack of public awareness, absence of specific laws and rules, as well as the poor application of legislation, contributes to the worsening situation in DC [19].

In Bangladesh, proper HCW management is a new phenomenon and the government is trying to develop a modern and sustainable approach to deal with HCW properly. There is no national policy on HCW management in Bangladesh, even the existing laws are outdated and impose low penalties, and even sometimes, no penalties for offenders [6]. A law has been developed for the proper management of medical waste, however, it needs to be implemented as soon possible [17]. The Department of Environment developed a hospital waste management pocket book in 2004 which was revised in June 2010 [22]. This book is supported by the medical waste management rules (2008) [23]. Still there is lack of appropriate, safe, and cost-effective strategy and only concerns itself with treatment, recycling, transport, and disposal options [6]. Until 2004 there were no authorized proper medical waste treatment plants or dumping facilities established. The situation is especially serious in DC and the problems associated with hazardous waste may be concentrated due to it being the largest urban center in Bangladesh. The city of Dhaka already has a variety of pollution issues, and medical waste may add a new dimension of potential health hazards [19].

The number of private hospitals, clinics, diagnostic centers and laboratories in the entire city is constantly increasing. This leads to an increase in the quantity of HCW generated [24]. PRISM Bangladesh, (a Non-Governmental Organization working in HCW management), reported that in DC there are more than 1,200 HCEs, which generate an estimated 200 tons of waste per day and 40 tons are infectious waste [19]. The Dhaka City Corporation (DCC) reported that the waste generated per person per day is about 0.5kg and the total number of private and public HCEs currently operating in DC comprises of 174 hospitals, 164 clinics, 209 diagnostic/ pathology, and 465 dental clinics [19]. All the HCEs have inadequate waste management systems which is a threat to both public health and the environment [6]. No HCEs segregated their generated wastes, except a very few [17]. Almost all HCEs often handled and disposed of their medical waste along with the general litter in DCC bins, drains or even in canals. In some cases, anatomical waste is also disposed into DCC bins [19]. As a result, an unhealthy and hazardous environment exists in and around hospitals that are affecting patients, hospital staff and other people who are exposed to these conditions [17]. Further, waste scavengers search for plastic materials, saline bags, syringes, cans and metals for resale. This may potentially lead to threats to the environment and health [19].

For the field of HCW management in Bangladesh, there are only three NGOs working closely such as PRISM (Project in Agriculture, Rural Industry, Science and Medicine) Bangladesh in DC, and BASA in Tongi and Shawpno in Bagura. They are collecting waste from HCEs for a nominal service charge. There are only 342 hospitals, clinics and diagnostic centers under the PRISM HCW management programme [6]. Therefore, the majority of the HCEs in DC do not have any waste management treatment plant. Until today, all the discharge their liquid waste into the general sewers or drains because none of them have any proper liquid waste management system, which results in the pollution of surface and ground water [17]. Recently some good initiatives have been introduced including manual and electric needle destroyers, as well as a small effluent treatment plant which is under construction, and a heavy-duty autoclaving machine also. Although the government of Japan has recently donated an incinerator, these small-scale initiatives are not sufficient to manage HCW properly in the city [17]. In order to improve HCW management and develop a management strategy for DC, it is necessary to understand and evaluate current practices in HCW management. Information regarding HCW management in DC is currently insufficient. Therefore, the main objective of this study was to assess the present management practices of HCW in DC and suggested some measures to improve the present conditions.

III. Materials and Methods

This study was conducted in Dhaka metropolitan city. The city stands on the bank of the river Buriganga and lies between 23°42`0" north latitude and 90°22`30" east longitude. It covers an area of 316 km^2, of which 126.34 km^2 is under the DCC and the total population is at 16,560,000 (BBS projection for metropolitan area), it is the largest city and administrative center of Bangladesh [19], [25]. In this study, a total of five HCEs (Government hospital, Private hospital, General hospital, Private clinic and Diagnostic center) were randomly selected in Dhaka metropolitan city under the two municipal administrative areas (namely Wards No. 49 and 56) for both the qualitative and quantitative studies in order to identify the current HCW management practices in the city. The HCEs were selected for this study based on the number of active beds, patients, occupancy rate as presented in detail in Table I.

A number of survey techniques were used to collect qualitative and quantitative data for the study; empirical field observation, structure questionnaire survey, and interviews in formal and informal ways. A total of 30 questions were presented to the cleaners, nurses, staffs, and doctors through face-to-face interviews to collect information considering waste generation, segregation and collection, storage, transportation and disposal. Several special interviews were arranged with the management authority of the HCEs to gain an in-depth understanding of the overall present situation of HCW in DC. The study was conducted from June 2016 to

September 2016 and a total of 152 questionnaires were handed out for the collection of data from the Dhaka Medical College and Hospital (DMCH-57), Bangladesh Medical College and Hospital (BMCH-35) Anowar Khan Modern Hospital (AKMH-30), Ibna Sina Clinic and Laboratory (ISCL-20) and Popular Diagnostic Center (PDC-10).

In order to know the quantity and rate of generation of waste (infectious, general, hazardous, plastic and sharp waste) were weighed by 20 kg special plastic container. Safety procedures were implemented including the use of masks and gloves prior to weighing the waste. The waste was weighed after being collected over two days, Tuesday and Friday, each week from each of the HCEs. After collection of all the relevant data, the gathered information was stored, edited and coded in a database for further analysis. The data from the survey was checked for consistency and completeness, and then analyzed using Microsoft Office Excel 2016.

IV. Results and Discussion

A. HCW Generation Rate

The number of active beds, inpatients, outpatients and total patients are shown in Table I. All wastes generated by the HCEs are considered as HCW. This study revealed that the generation rate ranges from 2.34 kg/bed/day to 2.86 kg/bed/day, with a weighted average of 2.61 kg/bed/day, as shown in Table I. Previous studies have reported that the average rate of waste generation for DC is 1.93 kg/bed/day, 2.63 kg/bed/day and 2.97 kg/bed/day [17], [26], [27]. A study revealed that the average rate of HCW generation for Ghana is about 1.2 kg/bed/day [15]. In Iran, the average rate of waste generation was reported as 2.78 kg/bed/day [20], for Liberia the waste generation rate was found to be of 0-7 kg/day [8], for Nigeria the rate was 0.81 kg/bed/day [28], while Ethiopia has an average generation rate of 1.67 kg/bed/day [10], and Cameroon has an estimated rate of 0.054 kg/bed/day [21].

TABLE I
Waste Generation Rates in Selected HCES

Character	HCEs					Total/ Ave.
	DMCH	BMCH	AKMH	ISCL	PDC	
Dependency	Government	Private	Private General Hospital	Registrar Private clinic	Registrar Private DC	
Active Beds	1,800	500	250	210	---	2,760
Outpatients	3,600	1,250	625	---	---	5,475
Total Patients	5,400	1,750	875	210	235	8,470
kg/day	4,228	1,430	665	567	325	7,215
kg/bed/day	2.34	2.86	2.66	2.7	---	2.61

*Waste generation rate in (kg.) Source: Field survey, 2016

Based on the analysis, the generation of HCW depends on some factors such as different healthcare center specializations, size and type of healthcare center, social and economic status of the country, the application of modern treatment facilities and the education level of employees and cultural features of patients, as well as the waste management activities and application of reusable items [15], [20]. The physical composition of the generated waste was found to be 75% general, 14% infectious, 5% plastic, 4% liquid and 2% sharp waste (Fig. 2).

The comparison of hazardous and non-hazardous waste is shown in Fig. 1. The highest amount of non-hazardous waste is generated by DMCH at 47.32%, whereas the lowest is PDC at 3.9%. On the contrary, the hazardous waste generation rate of DMCH is 12.73%, which is higher. Previous researches reported that the rate of non-hazardous and hazardous waste generation of 80-90%, 10-15% for Ghana [15], for Cameroon of 49%, 51% [21] and for Ethiopia, the rate was of 42.2%, 57.8%, respectively [10].

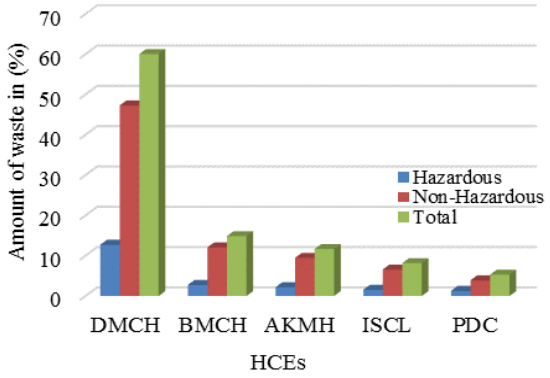

Fig. 1 The comparison of hazardous and non-hazardous waste

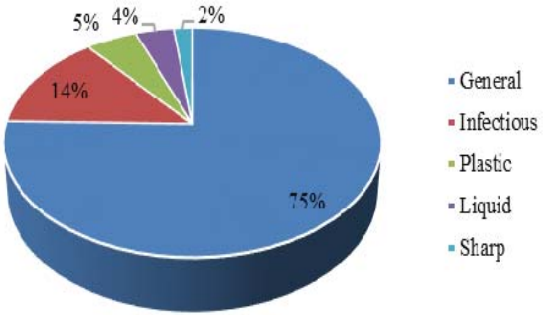

Fig. 2 Physical composition of the HCW generated by HCEs

A. Types and Quantification of HCW

In order to determine the quantity of HCW generation and composition of HCEs depends upon on several factors such as the number of active beds, size and types of HC center and type of health services provided, as well as the economic, social and cultural status of the patients, but it also differs on location and where the HCEs center is situated [17]. This present study indicated that the surveyed HCEs generated kitchen waste, medicine boxes, cotton bandage, amputated body parts, placenta, blood and urine bags, syringes without needle, saline bags, gloves, blood, laboratory chemicals, needles, blades, knives, and vial ampoules, among other items as shown in Table II.

TABLE II
AMOUNT OF WASTE WITH TYPES GENERATED IN ALL SELECTED HCES

Types of Waste	Amount of waste in (Kg)* with percentage in brackets					Total
	DMCH	BMCH	AKMH	ISCL	PDC	
General waste	3,425.52 (81.02)	1,152.58 (80.60)	521.69 (78.45)	443.96 (78.30)	190.28 (58.55)	5,734.3 (75.38)
Infectious waste	553.02 (13.08)	157.87 (11.04)	76.80 (11.55)	72.0 (12.70)	66.46 (20.45)	926.15 (13.76)
Plastic waste	107 (2.53)	43.61 (3.05)	29.9 (4.50)	27.21 (4.80)	35.81 (11.02)	243.53 (5.18)
Liquid waste	99.35 (2.35)	47.19 (3.30)	25.9 (3.90)	14.17 (2.50)	22.62 (6.96)	209.23 (3.80)
Sharp waste	42.12 (1.02)	28.74 (2.01)	10.64 (1.60)	9.63 (1.70)	9.81 (3.02)	100.94 (1.87)
Total	4,228 (100)	1,430 (100)	665 (100)	567 (100)	325 (100)	7,215 (100)

*Waste generation rate in (kg.) Source: Field survey, 2016

B. HCW Segregation and Collection

Segregation of waste at the source into suitable color-coded bins is vital for proper waste management. The medical waste management rules (2008) stated that waste should be segregated for collection by using different colored bags and containers (black bag for general waste, yellow bag for infectious waste, green bag for plastic waste, red bag for sharp items, and blue bag for liquid waste). This survey showed that 45% of the HCEs segregate waste properly, while 55% of the HCEs have not yet implemented segregation system for all HCW waste. Only 72% of HCEs used color coded bins for in-house segregation, while for 10% labeling of waste containers/ bags has been adopted. Because of the absence of appropriate labeling, it is difficult for the public and workers to identify the source and the type of HCW. According to Table III, infectious (21.5%) and sharp (22.9%) wastes are properly collected by HCEs. A survey conducted by PRISM Bangladesh in 2013, found that 9.5% of HCEs collected their waste properly, while 57.5% of ECHs collected waste without any management systems and 25% follow partial management systems [19]. In some cases, infectious waste was mixed with municipal waste because of the lack of sufficient segregation; while in other cases, the medical waste was collected as part of the general municipal waste. In some HCEs, the cleaners and workers handled medical waste without any protective equipment [2]. This poor and improper segregation started from the point of generation and continued until final disposal which represents a serious health risk for associated persons [6], [27]. These practices may increase the cost of disposing medical waste and the risks posed to public health and the environment [2].

C. Storage and Transport

The temporary storage location, storage containers and storage management have a direct impact on the resulting environmental and health risks at the hospital, which must be well sanitized and secured for access only to authorized personnel [2]. This study revealed that for most of surveyed HCEs, there is no proper designated storage facility, with the exception of the 20% that have temporary storage facilities, which is less than Iran, where 26.7% of hospitals have well sanitized and safe temporary storage areas [29], while in China, 53.3% of hospitals used standardized packaging containers for storage [2]. A survey conducted by PRISM Bangladesh (2013), found that most of the HCEs have no temporary storage system and that they disposed all of their waste into DCC bins. In some cases, waste is temporarily stored in a room or open space, and therefore, the storage areas for medical waste are not well secured or satisfactory [19].

TABLE III
RESPONSE TO THE COLLECTION AND SEGREGATION OF HCW

Question	Response (%)
Is the waste separated into separate bins?	Y-45%
Are waste bins labeled?	Y-10%
Are color-coded bins used for in-house waste storage?	Y-72%
Is infectious waste collected separately?	Y-21.5%
Are the sharps collected separately?	Y-22.9%

Y*: Yes Source: Field survey, 2016

Medical waste is transported through pre-established routes, which include specific corridors and elevators on each floor, and are strictly used to transport waste from the intermediate storerooms to the final storerooms in the basement of the hospital. According to scientific standards, infectious waste in tropical areas can be kept in a temporary storage area for 24 h during the hot season and up to 48 h in cooler seasons [2]. The DCC is responsible for off-site transportation and they collect 54% of waste from their bins as well road side bins. During this survey, it was also found that the DCC collected all non-hazardous waste (general waste) by vans each morning and transported it to final disposal site. The remaining 46% of waste collected by NGOs like PRISM Bangladesh of separate container and transported by specially designated vehicle for final disposal [19]. In many cases, the cleaners, drivers, and workers handle the HCW bags manually without protective measures. The used plastic bags, containers and vans are not properly maintained and HCW was often transported together with municipal waste.

D. Disposal

The disposal practices for different types of HCW generated by the HCEs were investigated in the study. The survey results indicate that more than 70% of HCEs dispose of waste into DCC bins or nearby road side bins. Very few HCEs receive services from some private company engaged in refuse collection services. Only the DMCH installed two manually operated incinerators, but these incinerators have been out of service for the last five years. The government of Japan donated an incinerator which as installed at the Matuail plant; however, it is not large enough to treat huge amount of HCW. Organic infectious waste and sharp items are buried in the separate concrete burial pits at the newly constructed plant. There is no system or practice of destroying needles from used syringes. Recently, few HCEs have introduced both manual and electric needle destroyers to protect against the resale and reuse of syringes [17]. Still now, it is inadequate to handle all the HCW in the city with the limited disposal facilities. According to the survey, all the HCEs discharge their liquid waste directly into the municipal sewer systems or down

normal drains, especially in the Dhanmondi area where they discharge all liquids directly into Dhanmondi Lake, from where it eventually enters into the Buriganga River via drainage systems and impacts negatively on human health and the environment.

E. Training and Awareness

Training programs relating to HCW management for nurses, doctors, and health personnel were poor; about 62.4% of HCEs had not provided training to nurses, doctors and health personnel on HCW management and its potential negative impacts. Few HCEs (37.6%) provided limited training for nurses, cleaners, and support staff. The survey indicated that more than 70% of respondents suggested practical training rather than traditional theoretical training is useful for HCW management. The majority (85%) preferred awareness training should be provided to management authority of HCEs. On the other hand, training programs for waste handlers, operators, and health personnel (nurses and doctors) were suggested by 80% of respondents. Most government HCEs do not have budgetary provisions to arrange training for nurses and doctors. It can also be noted that almost all nurses showed their willingness to participate in training programs, if the relevant authority provided the facilities. Few private HCEs arranged training programs for their staff out of their own budget. One-third of the respondents (68.9%) opined that there was a lack of waste management awareness materials.

V. Conclusion

The number of private and government HCEs throughout DC are constantly increasing. This leads to an increase in the quantity of HCW generation that is disposed of improperly. Although the Directorate General of Health Services (DGHS) developed the medical waste management rules in 2008, aimed to ensure standard procedures for proper waste management systems for all HCEs, there is still lack of an appropriate, safe, and cost-effective strategy and only concerns itself with treatment, recycling, transport, and disposal options. There is still a need for a strategy for HCW management based on integrated waste management options which would then need to be supplemented with the appropriate policy guidance and enforcement at the national level. To attain this, policy makers and hospital administrators require both technical assistance and economic support.

The main findings and recommendations of this study are:

- The estimated HCW generation rate ranged from 2.34 to 2.86 kg/bed/day with a weighted average of 2.61 kg/bed/day.
- The segregation and collection procedures of different types of HCW have been conducted properly in 45% HCEs. The labeling of waste containers/bags has been adopted in 10%, which is not satisfactory, while color coded bins are used by 72% of HCEs; source segregation, handling, transport and disposal needs to be more specific and regulated.
- Few HCEs (20%) have temporary storage facilities and others were not proper designated storage areas, and also, still missing effective recycling.
- The vehicles used for transportation of HCW was not upgraded and failed to meet the safety requirements. There is also a need to upgrade and central vehicles for transportation. The cleaners and workers handle the waste without Personal Protective Equipment (PPE).
- The study indicated that there is lack of sufficient practical training for different level of healthcare staff, cleaners, waste handlers, nurses, doctors, management personnel and maintenance staff.
- All HCEs discharge their liquid waste directly into the municipal sewer systems or normal drains. There is a need for a proper treatment plant for the handling of liquid medical waste.
- There were no separate specific places to dispose of HCW outside of the HCEs. There is a need for designated, separate dustbins for HCW.

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