Paper ID: IE-P37

Quantification and Physical Categorization of Waste Generated by Different Healthcare Entities in Chittagong Metropolitan Area, Bangladesh

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Abstract

Quantification of healthcare waste (HCW) generated by healthcare entities (HCEs), especially in municipal areas, is important in order to assess the potential risks associated with HCW handling and management besides guiding the policy makers in developing HCW management guidelines. In Bangladesh, research to this end is scanty and non-coordinated. This research - based on primary data from 300 public, autonomous and private HCEs in Chittagong City Corporation (CCC) - aimed at obtaining HCW categorization data. We used both questionnaire survey and actual weight measurements of waste samples in this study. The spatial distribution HCEs in the city is not even, rather the map we prepared based on GPS locations indicated three clusters of HCEs - KB Fazlul Kader road, Panchlaish residential area and Jamal Khan. HCEs increased in number noticeably within three consecutive decades since 1991. The city generates 15 to18 tons of HCW every day which includes respective contributions from hospitals, clinics, diagnostics, maternity, diabetics, eye and dispensaries as 6,7.2,4,1.6,0.15,0.42 and 0.25 tons/day which is equivalent to 1.45,2.25,0.13,1.82,0.26,0.12 and 0.01 kg/patient/day containing 20,30,18,55,13,10,48 and 50 percent hazardous wastes respectively. Color coding at temporary storage for source segregation was found only in public hospitals. Overall, situation of healthcare waste management in CCC is not satisfactory and we need stringent policy and guideline for HCW management with strong enforcement.

Key words: *Healthcare waste, categorization, generation, quantity, management, composition and environment.*

1.0 Introduction

Hazardous wastes are the materials which contain germs and sharp substances, if managed improperly, inflict losses of varying magnitudes to the environment while affecting human health [1]. Common sources of hazardous wastes include industries, healthcare entities, research labs and to a lesser extent households [17; 24]. Among different categories of hazardous wastes, health care wastes (HCW) are a grave concern in developing countries like Bangladesh which lack in proper statistics, technology and environmental management credentials [19]. Traditionally, HCW or medical waste or hospital waste are defined as wastes generated from diagnosis, monitoring and preventive, curative and palliative, immunization and research activities in field of the veterinary and human medicine [8]. It is worrying that the rapid and unplanned urbanization in developing countries pushed ahead by high population growth lead to rapidly increasing number of healthcare entities (HCEs) and intensification of HCW quantities and diversities [5]. HCWs are usually categorized into *non-hazardous* items including packaging materials, waste from administrative activities, foods etc., and *hazardous* items including infectious, sharp, pharmaceuticals, genotoxic chemicals, heavy metals and pressurized wastes etc [7]. On the other hand, HCWs can be subdivided into pathological, sharp, infectious, chemical, radioactive and liquid wastes [7; 15] which may contain toxic, reactive, radioactive, poisonous, carcinogenic, irritant, mutagenic, teratogenic, corrosive, explosive and flammable ingredients [18] requiring special attention due to their toxic nature [16; 1] and infection potential [10; 22; 20; 9]. The quantity of healthcare wastes generated by different categories of HCEs varies, and the composition of HCW varies between and within countries. These variations are attributed to the size of HCEs, proportion of in and out patients, type of HCEs and specialization, adopted waste segregation options, proportion and use of reusable items, and above all the prosperity of the

country [23]. HCW in China, as shown by Li Rundong [14] contained 53%, 17%, 15%, 3% and 12% paper, organic, plastic, metals and others categories respectively. In Sri Lanka, as reported by Haniffa [12] from 538 hospitals with 52702 beds, the daily generation of HCW ranged from 76623 kg to 170789 kg. In Bangladesh, according to 2011 records of Directorate General of Health Services [11], there are 583 primary, secondary and tertiary public HCEs with 65,470 beds while the number of registered private HCEs was 7,623 of which 2,501 were hospitals and clinics and the rest were diagnostic centres. All these had 42,237 total installed beds. Prism Bangladesh [17] showed that in Dhaka Medical College and Hospital (DMCH) – one of the biggest teaching hospitals, alone generates about 3609 kg HCW per day at 2.65-0.67 kg/patient/day waste generation rate with 19.8% of it being hazardous. In Rajshahi, a study encompassing 44 HCEs reported generation of 22 kg pathological waste, 30 kg plastic waste, 20 kg soft waste, 7 kg sharp waste, and 320 kg general waste per day [2]. However, this baseline survey measured 349 kg medical waste per day from the mentioned hospitals/clinics/diagnostic centers with when Rajshahi Medical College Hospital (RMCH) as the largest single contributor. On the other hand, in a study in Chittagong – the second largest city of Bangladesh, showed generation of 0.57 kg HCW /patient/day segregable into eight categories [6]. According to our calculations Chittagong Medical College Hospital (CMCH) generated 0.94 kg/bed/day of HCWs which was 0.48 for Chittagong General Hospital, 1.13 for Memon Maternity Hospital [4]). Different scenario of HCW generation was found for private HCEs, for example, at the private teaching hospital – the Bangabandhu Memorial Hospital, it was 1.52 kg/bed/day which were 1.79, 1.56, 0.9 and 2.4 kg/bed/day respectively for National Hospital (private hospital) Chittagong Diabetic Hospital ; Chittagong Eye Infirmary Hospital and Surjer Hasi Clinic (Private maternity). Besides, Metro Diagnostic center produced 0.08 kg HCW/test/day. A study in Khulna city reported 0.15 kg/bed/day HCW generation rate based on data from 8 hospitals/clinics [19]. For this city, another study reported average waste generation rate for hospitals and clinics to be 0.934 kg/bed/day - much higher than 0.0414 kg/person/day for diagnostic centers and outdoor clinics [21]. However, in from the aforementioned literature, the lack in data became evident on detailed categorization of solid wastes including all the different categories of HCEs in Chittagong. Alam et al. [6] worked only on wastes from CMCH. However, such category wise waste generation scenario and waste generation rates are very important for comprehensive HCW management, especially in a scenario when private HCW management entities like Innovation Sheba Sangstha (ISS) are entering into business. Also, we hypothesized that such study is very relevant to the accurate estimation of potential risks from HCW and HCEs, for the formulation of law and policy on HCW management besides providing information to HCW management organizations. Therefore, we undertook this study within CCC and accomplished it between January and July, 2012. We used semi-structured questionnaire, GPS device, digital camera and measuring instruments for waste categorization and weight measurement.

2.0 Methodology

2.1 Study area selection

We included the entire Chittagong Metropolitan Area for the purpose of this study. The city is located between 22˚14’ to 22˚-24’-30” N Latitude 91˚46’ to 91˚53’ E Longitude. The river Karnafully (Hossain, and Alam, 2012) runs along the north border of the city and on its west side lies the Bay of Bengal. However, we included only the HCEs which are clustered into some certain zones of the city hence, in strict sense; the whole city was not needed to be surveyed.

2.2 Reconnaissance survey and questionnaire survey

In order to facilitate the entire process, we conducted few reconnaissance surveys within the study area. Based on the results we fine tuned our survey plan, the questionnaire and the mode of waste collection and measurements. We conducted questionnaire survey in all pre-target HCEs within metropolitan area by taking into consideration all the different categories of healthcare establishments.

2.3 Field visit and data collection

We visited many times the HCEs to judge the most suitable time for taking images and talking waste sample and quantify the wastes. We took official permissions from all HCEs for survey, waste collection and measurements as well as for taking photographs using digital camera. We availed the experiences of workers and nurses.

2.4 Mapping

GPS locations (latitude and longitude) were collected for all the HCEs included into our survey who are known to discharge their HCWs into the dustbins within the metropolitan area. Then we compiled all the collected readings in MS excel sheet and using the online GPS visualize tool online, we placed the location points on the map of Chittagong city (Figure 1).

2.5 Data analysis

All our gathered data we compiled into MS word and MS excels, version 2007. We analyzed the data by using MS excel and SPSS V16.0 (Statistical Package for Social Sciences) software.

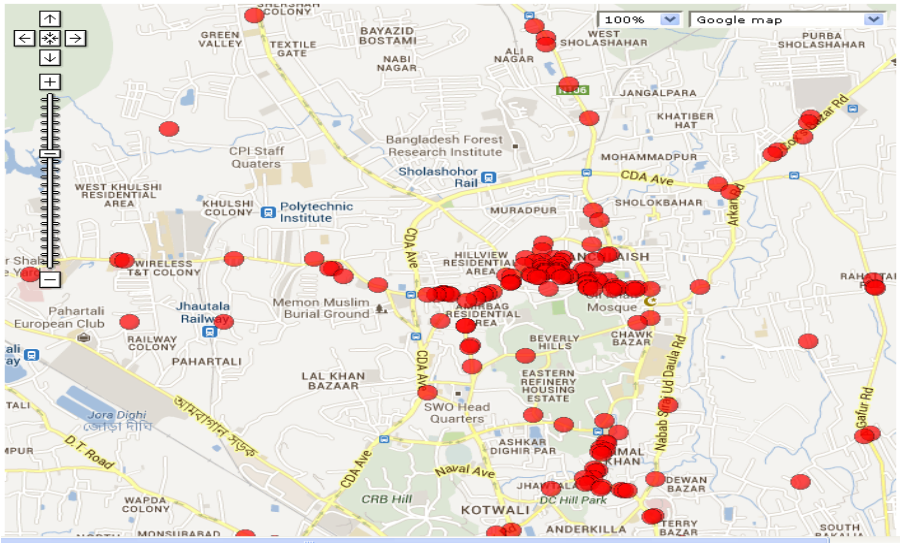

Figure: 2.1: Location map of surveyed HCEs in Chittagong city area.

3.0 FINDINGS AND DISCUSSION

3.1 Temporal trend of HCE numbers

Chittagong, being the expanding commercial capital and the second largest city in Bangladesh, is home to an increasing population of about 5 million. The rapid growth of population and associated urban sprawl led to the rapid rise in the number of HCEs which in turns responsible for the generation of large quantity of HCW. The total number of different category of HCEs in Chittagong was quite small at the time of the liberation war in 1971. From figure 3.1 we can see noticeable increase in the numbers of different categories of HCEs between time intervals 1991-2000, 2001-2010 and 2011-2012.

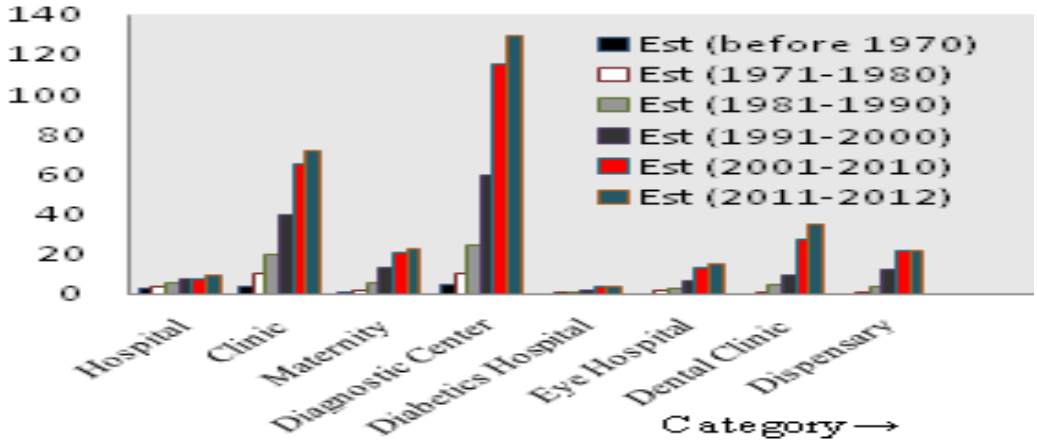

Figure 3.1: Different category of HCEs increase in different time interval

But in 2011-2012 time intervals total number of each category of HCEs increase is low because duration is short than other intervals. For example, from figure 3.1 we can see that before 1970 there were no maternity, eye hospital and dental clinic in CCC and only three hospitals and four clinics existed. Also, during 2001-2010 times interval there was no increase in the number of hospitals while the clinics which are private HCEs increased rapidly between all time intervals studied. This finding is indicative of a poor non-centralized HCW management scenario as we have observed since HCEs are smaller in size but many in numbers. In addition, figure 3.1 indicated the absence of diabetics hospitals, eye hospitals and dental clinics in CCC before 1970 and dental clinics were also absent between 1971-1980 time interval as well. Diabetics' hospitals, eye hospitals and dental clinics increased in number between 1991 and 2010 which indicated a relatively recent trend of building specialized HCEs in CCC. On the other hand, total number of private physicians' chambers, dispensaries and diagnostic centres in CCC increased noticeably over the last two decades in CCC.

3.2 Different categories of HCEs in CCC

Among the HCEs found in CCC area, there were different categories including hospitals, clinics, maternity centres, dispensaries, diagnostic centers, eye hospitals, diabetic hospitals, dental clinics and regional office of pharmaceutical companies in CCC. The respective numbers of HCEs under each category in CCC are 7, 72, 23, 22, 130, 15, 3, 30 and 65 (Fig 3.2). Hospitals are large in size and handles majority of the patients but these are smaller in number. Diagnostic were comprises the highest in number among HCEs in CCC and clinics were next to them. Diabetics hospitals, eye hospitals and maternities were very few in numbers compared to population size of CCC.

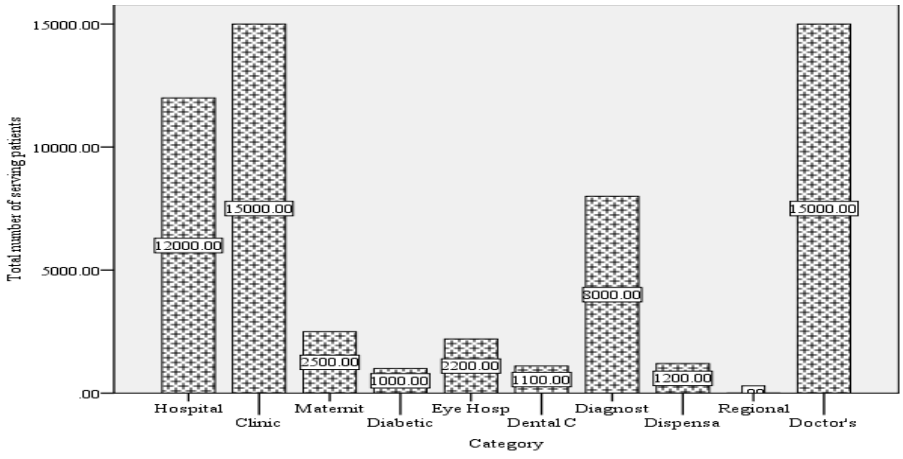

Figure 3.2: Total number of different category of HCEs in CCC

3.3 Patients served by different HCEs in CCC

Compared to the size of population in CCC, the numbers of HCEs are insufficient. Since the private HCEs are costly, the majority of poor patients in CCC rely on public hospitals which are smaller in numbers. Affluent patients usually generate larger quantity of HCW than poor patients. With the increasing number of HCEs, the total number of patients getting healthcare services also increases. The total number of patients served by different category of HCEs every day in CCC are 12000, 15000, 2500, 1200, 8000, 2200, 1000, 1100 and 15000 respectively by hospitals, clinics, maternities, dispensaries, diagnostic centers, eye hospitals, diabetic hospitals, dental clinics and private physicians' chambers (Fig 3.3). Hospitals, clinics and private physicians' chambers are the major source of healthcare services in CCC. It was found that, in CCC maternity related services are mainly provided by different NGOs such as Niskrithe, Mariestopes, Red-Crescent and BRAC.

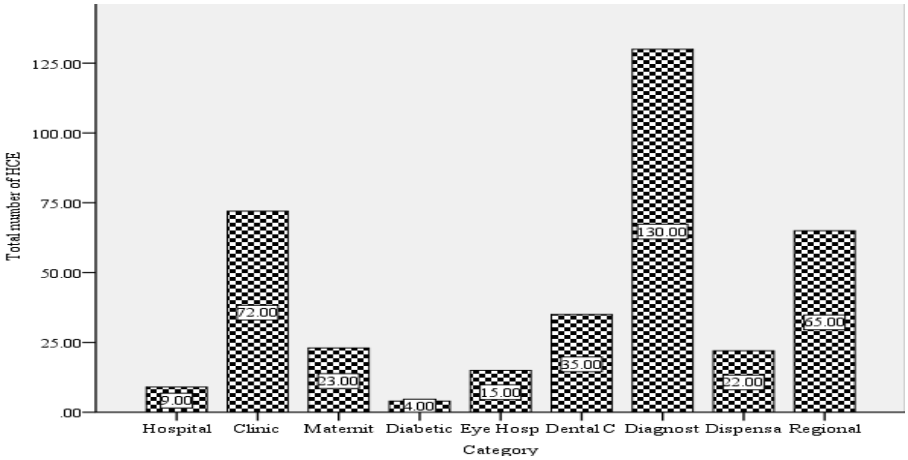

Figure 3.3: Total number of serving patients/day by different category of HCEs in CCC

3.4 HCW generation by different categories of HCEs

The total HCW generation in CCC was 15 to 18 tons/day from all categories of HCEs. But quantity of waste generated by different HCEs depended mainly on their sizes, service facilities and the number of patients served as well as the social and economic status of their patients. We found that the total HCW generated from each category of HCEs are 6, 7.2, 1.6, 0.25, 4, 0.42, 0.15, 0.35, 0.65 and 0.15 tons/day respectively from hospitals, clinics, maternities, dispensaries, diagnostic centers, eye hospitals, diabetic hospitals, dental clinics, regional office of pharmaceutical companies and private physicians' chambers (Fig 3.4). When brought down to kg/patient/day, HCW generation from respective HCEs stood at 1.45, 2.25, 1.82, 0.01, 0.13, 0.12, 0.26, 0.32 and 0.01. Due to their bigger sizes and whopping patients' numbers, hospitals generated the largest quantity of HCW. Though each clinic generates smaller quantity, their number is more and their HCW footprint per patient is large; hence in total their contribution to HCW is large. Diagnostic centers also generates considerable amount of HCW due to their large number though their rate of waste generation per patient is lower. Both local government- and NGO-ran maternities generated similar amount of HCW. Eye hospitals, diabetic hospitals, dental clinics, dispensaries and private physicians'chambers were found to generate very small quantity of HCW but as their number is high, the total amount was large. Therefore all category of HCEs contribute little or more HCW into total MSW stream ultimate result of which is conversion of non-hazardous waste to hazardous if not managed separately and properly. So it requires special attention for HCW handling and management which we found not adequate in CCC.

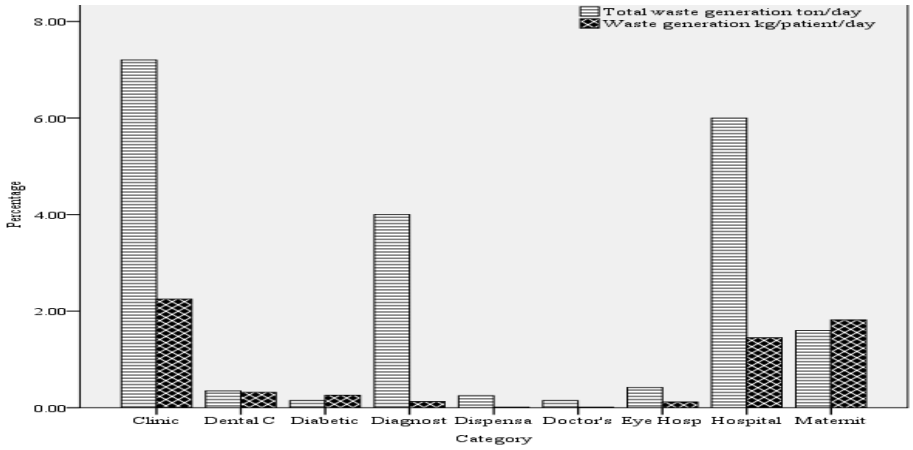

Figure 3.4: Total HCW generation rate tons/day and kg/patient/day by different category of HCEs in CCC

3.5 Physical categorization of HCW from HCEs in CCC

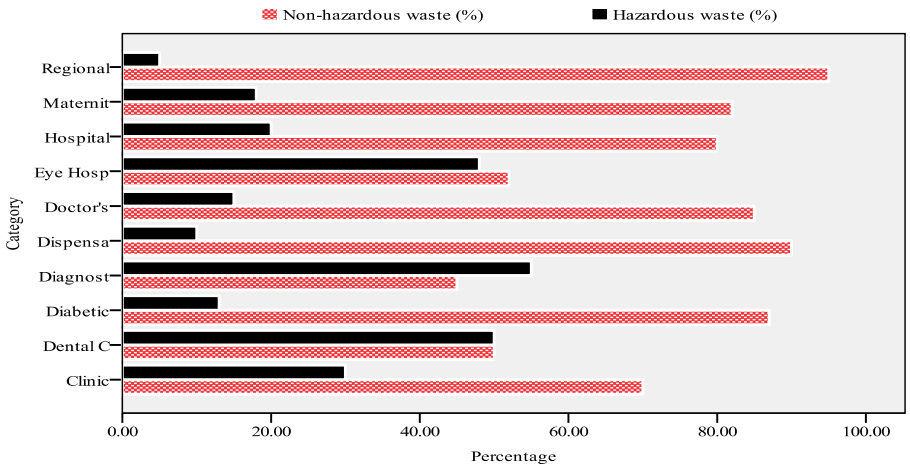

Figure 3.5: Percentage of hazardous and no-hazardous HCW generated by different category of HCE

Hospital – Figure 3.5 shows that the HCWs from hospitals comprises of 20% hazardous and 80% non-hazardous wastes. However, more verities of HCW were observed to be generated from hospitals as they serve varieties of patients. Only in two public hospitals were found to follow color coding system for temporary storage of HCW within the hospital premises. Others do not follow color coding, rather they use different sorts, shape and strength drums for HCW collection. Compared to public hospitals, private hospitals use strong drums and their surrounding environment is cleaner. Workers collecting HCW were not found to wear any protective gear which was a worrying finding.

Clinics – Clinics also generate similar varieties of HCW in smaller quantity compared to hospitals. However, they generate comparatively more hazardous HCW than hospitals. Figure 3.5 indicates that the HCW from clinics contain 30% hazardous and 70% non-hazardous wastes. Alike hospitals, clinics also do not follow color coding system but they use comparatively strong drums and some are contracted with private company for managing their HCW. But many of them directly discharge their HCW to municipal dustbins or open road and create an unhygienic environment.

Maternities – Maternities generate less quantity of hazardous HCW compared to hospitals and clinics with 18% of its wastes being hazardous (Fig 3.5). Their entire HCW handling and management system is comparatively better than others but they don't follow any color coding system for temporary storage of HCW.

Eye hospitals – Eye hospitals or clinics generate small quantity of HCW but their wastes contained 48% hazardous items (Fig 3.5). It was also noticed that they burn their major part of their hazardous HCW by them.

Similar to others, they were also found not to follow a clear color coding system for temporary storage of HCW and most of their wastes are thrown to municipal dustbins.

Dental clinic – There is only one dental hospital in CCC but many dental clinics are there where patients are not admitted rather treated as and when arrived. They generate very little quantity of HCW but with 50% hazardous content. They mainly generate some infectious HCW. They mix up all categories of wastes they generated to discharge them to nearby municipal dustbins.

Diabetic's hospitals – Diabetic hospitals generated similar quantity of HCW as clinics but with less hazardous content which was only 13%. They also do not follow color coding system and release their wastes into municipal dustbins.

Diagnostics centers – Though total number of diagnostic centers in CCC is more but they generate smaller quantity of HCW including fewer categories than clinics and hospitals. However, their hazardous content is high (55%). Though they don't follow any color coding, they usually segregate sharp HCW before releasing into municipal dustbins.

Dispensaries – Dispensaries generate only little quantity of sharp hazardous waste (10%) and others wastes are non-hazardous (90%). They mix up all of their generated HCW and then discharge to municipal nearby dustbins.

Regional office of pharmaceutical companies and doctor's private chamber – Regional office of pharmaceutical companies generates mainly non-hazardous paper wastes from packaging materials and product flyers. In contrary, private physicians' chamber generates small quantity of sharp HCW such as syringes, saline bags, blades and gauges etc. The hazardous content in wastes from these two sources is 5% and 10% respectively. All of their generated HCW are disposed to municipal dustbins mixing up.

3.6 Discussion

Their overall environment of HCW management was not satisfactory at all in CCC. Therefore, it is necessary to form monitoring body by hospitals to plan and implement proper HCW handling system. Only Chittagong Medical College Hospital and Chittagong General Hospital were found to follow color coding system in CCC which was also not proper and regular. All other HCEs in CCC use different sorts and strength drums, basket, box and bowl for collecting HCW without following any standard collection bin. Some of them little quantity of sharp HCW segregates but finally discharge to municipal dustbins without any treatment which converts harmless MSW to hazardous waste. Comparatively better HCW handling and management system was found in NGO running maternities which can be used as initial model for HCW handling. Since the major portion of generated HCW is non-hazardous, they can be recycled or safely managed if strict color coding system is adopted for them for the purpose of source reduction and re-utilization. Nevertheless, government and concerning authorities should monitor HCEs and implement related regulations strictly to improve current condition.

4.0 Conclusion

Rapid and unplanned urbanization is responsible for large quantity of MSW generation in urban areas as well as HCW. Though HCW contributes only 1% to the total MSW streams, it is important because when it gets mixed with MSW convert them to hazardous. Hospitals and clinics contribute major quantity of HCW to MSW stream while total HCW contribution of diagnostic centers is also noticeable. In contrary, the rest category of HCEs in CCC generates less quantity of HCW. This study reveals that total HCW generation of CCC is 15-18 tons/day. Compared to public, HCWM scenario in NGO-run HCEs and private HCEs is slightly better. In conclusion we can say that HCW management related rules and regulations should strengthen and strictly enforced. Considering field observation and secondary data, we felt the need to deeper investigation into HCW situation to find out acceptable a model for CCC to manage its HCW environmentally friendly manner.

Acknowledgement

Special thanks goes to Dr. Saleh Uddin, Lecturer, Department of Physiology, Chittagong Medical College Hospital (CMCH) and Dr. Akram Hossain, Medical Officer, Emergency Department, Chittagong General Hospital (CGH) and doctors, staffs, nurses and workers of different HCEs and CCC staffs who have cordially provided us information throughout the progress of this study.

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