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Medical Waste: Environmental Health Hazard in the Northern Part of Bangladesh

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Authors' contributions

This work was carried out in collaboration between all authors. Author MMR designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author TAT managed the literature searches, analyses data of the study performed and author MAP managed the experimental process with the current studies. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: This study explores the types of Healthcare Establishments (HCEs) and their amount and kind of medical waste generation and the types in 27 HCE in Rangpur City Corporation (RCC) area include hospitals, clinics, and diagnostic canters. Private HCE's providing surgical, obstetrical, dialysis and pathological services were integrated in this survey because they may generate large amounts of transmittable waste and can major source of environmental health hazard.
Methodology: Primary data collection methodology was adopted including questionnaire survey, observational approach and formal dialogue session using a Population Proportionate to Size (PPS) stratified plan.
Results: The overall mean general waste production rate is 1.7 kg/bed/day at all the surveyed HCE in RCC area which ranged from 0.5 kg to 5 kg/bed/day. The highest amount of infectious

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wastes generated from the HCE which have surgical facilities about 80 kg/day. The average waste generation rate was 1.5 kg/bed/day. This study suggested that in RCC region most of the private HCE's employee has no in-depth knowledge about medical waste management in the context of environmental hazard and its management system.

Conclusion: In addition, this study also suggested that knowledge on environmental health is a significant issue among the surveyed HCE employees to protect the threat of public health.

Keywords: Medical waste; waste generation; waste management; environment; health hazard.

1. INTRODUCTION

Biomedical waste plays a key role in the transmission of diseases to living organism and contamination of the environment [1,2] as it contains highly toxic chemicals, heavy metals and pathogenic viruses and bacteria. Risk minimization for medical waste has become a major concern worldwide. Many developed countries have maintained a proper management system and safe disposal of biomedical waste to minimize the risk through modern technologies such as incineration, autoclaving etc. However, medical waste has not received adequate attention in developing countries particularly when it is disposed of together with the domestic waste [3].

Bangladesh is a developing country facing rapid population growth and environmental pollution. A defining trend for its economy and society is the rapidly growing urban population. As a result of heavy influx of migrants in urban area healthcare services are a growing feature [1]. This is an emerging concern for newly declared City Corporation area Rangpur, the main city of northern part in Bangladesh. The rapid growth of disorganized healthcare establishments (HCEs) in Rangpur City has resulted in an environmental health hazard. The facilities for medical waste disposal from HCEs cannot cope with the growing demands. Hitherto no authorised and/or unauthorised biomedical waste treatment plant has been established in Rangpur City Corporation (RCC) area. This is due to the lack of public awareness, an absence of specific laws and rules and poor application of legislation by the Local Government. The problems associated with hazardous medical waste are concentrated in Rangpur city, due to it being the largest urban centre in northern Bangladesh. Rangpur as a new city corporation, already has a variety pollution issues, medical waste may add a new dimension of potential environmental health hazards. Therefore, the scale of problem is large and the need for detailed scenario and accurate research study is urgent.

The aim of this research study was to observe the processes for biomedical waste disposal in RCC area and to investigate the potential risks to environmental safety, environmental health and finally to the wider environment.

Being a new city corporation, rapid population growth has resulted in a demand led increase of hospitals, clinics, private individual practitioners, diagnostic centers and pathology services in RCC. Therefore, the estimation of total biomedical waste generation is needed to develop a proper waste management plan to minimize the risks for city dwellers.

Any waste management plan should be based upon a reliable estimate of the amount of waste generated [4] and the objective of this study was to use a rigorous sampling method to gain a reliable estimate of the hazardous and non-hazardous waste generated by HCEs in Rangpur City. This study is the first to attempt an estimation of biomedical waste generation and to identify possible risk factors in a new city area. A review of the literature suggests that the proportion of waste produced in HCEs in a new city area in developing countries has not previously been estimated and considered as a source of infectious waste. It, too, may have significance in planning and environmental management.

2. RATIONALITY OF THE STUDY

The quantification of medical waste generation is an emerging worldwide concern. The rapid growth of medical and patient related services has resulted in an increase not only in the use of chemicals and drugs, but also increase in the use of disposable items and consequently, large amounts of medical waste are being generated on a daily basis. In most developing countries there is a growing concern that the enormous amount of hazardous medical waste generated, not only results in a huge disposal costs, but also creates the potential for the spread of diseases.

In the study area, there has been no rigorous identification and estimation of medical waste generation based upon a thorough HCE survey. Thus, quantitative estimation and qualitative assessment of medical waste generation is needed to estimate the potential risk and as a basis for any waste management plan for a pollution free city. Therefore, conducting this study results will provide medical waste generation in a broad range of the HCEs through a full coverage of HCEs situated in the RCC area. These estimates were obtained by surveyed sampled HCEs, including non-residential diagnostic, pathology centres and dental clinics. It was intended to gather information that would contribute to the development of medical waste management plans for the RCC area as an example of developing countries, which could be adapted according to circumstances. It is likely that this would be helpful to minimize the risks of health and safety. In exploring these rationalities the study is timely in the context of a newly developing city corporation, as an area like Rangpur.

3. THE TERM BIOMEDICAL WASTE IN THE PRESENT STUDY

Biomedical waste is defined as any solid or liquid waste that is generated from treatment of human beings in a hospital or clinic, from clinical diagnosis and pathological testing and from medical research [5]. It comprises sharps, non-sharps, blood, body fluids, dressing materials, surgically removed body tissues, chemicals, pharmaceuticals, medical devices and radioactive materials [6]. The waste generated from HCEs both as hazardous and non hazardous are considered as medical waste in this study. In the present study, the term biomedical waste defines all kind of waste generated from healthcare establishments such as general waste, sharps, pathological waste, kitchen waste, mortuary waste etc [7]. This therefore includes both non-hazardous and hazardous waste constituents.

3. METHODOLOGY

3.1 General Description of Survey Area

The selected study area is located in the middle part of Rangpur district (Rangpur City Corporation area). Rangpur is the largest city and administrative centre in the northern part of Bangladesh. The city is situated on the bank of Teesta River. At present 'Rangpur City Corporation' is a self-governing body charged with the running of affairs for the city. The City corporation area is divided into 35 'wards' (administrative zone). Rangpur is undergoing an expansion into a modern metropolis and is fast becoming the political, cultural, commercial and industrial heart of the northern part of the country.

3.2 Selection of the HCEs and Waste Estimation

The quantity of waste generated was estimated by collecting and weighing waste from a representative sample of HCEs over a period of 5 months in 2013. The population of HCEs (66) in Rangpur was defined by a list supplied by the Directorate General of Health. These were sampled according to a desired 90% confidence level using a Population Proportionate to Size (PPS) stratified plan [1,3,5] considering three types of HCEs: (1) hospital services including pathological and diagnostic laboratories, teaching and research facilities (2) clinics and (3) diagnostic centres as described by Patwary et al., [4]. This suggested a sample size of 27 HCEs, which is around 41% of the total population. Each HCE was assigned a unique number, and a table of random numbers was used for selection of the sample. Where substitutions were required, the nearest un-sampled HCE in the same category was chosen. Four substitutions were required due to inaccurate addresses. As such published lists often tend to be out of date, this was not considered to have introduced a significant bias. Five substitutions were required for HCEs that were unwilling to take part in the survey.

The fieldwork was carried out by a main researcher and a team of 5 students from Geography and Environmental Sciences, Begum Rokeya University Rangpur as a field investigator. Waste generation data were recorded as described the method by Patwary et al. [1,4]. This method was applied to all departments of each sampled HCE.

3.3 Participant Selection and Qualitative Data Collection

Fieldwork was started by social network mapping, adopting an observational approach, over a 5 months period in 2013. This technique is normally used in field based data collection procedures to elucidate relationships between a community and its environment. Initial

observation suggested four significant and distinct target groups:

1. Employees of the various departments in the Health Care Establishments (25).
2. RCC waste collectors, employed by RCC to collect waste from road side bins and to transport it to designated dumping places (11).
3. Medical waste scavenger (09), and
4. Medical waste recycler (12).

Having identified these potentially significant groups, each group was sampled according to purposive, authoritative, convenience and adaptive sampling for roaming population plan appropriate to that type of population. Thus a total of 57 participants were surveyed across the four groups.

An observational approach was adopted as it reduces the effects of the data collection process on the behaviours of the observed population. During the observational approach, photographic data were also collected, using a digital camera, on different activities of HCEs, treatment facilities, recycling activities, scavenging activities and other phenomena related to biomedical waste in the study area. Collected photographic data were interpreted and illustrated to analyse the research findings.

A number of formal interviews (including both closed and open questions) were arranged, as judged appropriate in each individual circumstance [8]. A number of informal dialogue approaches were used in situations where the formal technique was not judged to be appropriate. The dialogue approach involved face-to-face interviews between the researcher and selected informants at times and places where the participant's interest could be obtained and retained; interviews were conducted in tea-stalls or in hotels, near to a road side bin or in a road, at waste collection time or in any free time, during the day or at night, in good weather or bad. Quantitative data was recorded in SPSS (version 16) and analyzed by descriptive statistical methods, and then illustrated and interpreted with a range of qualitative mode of analysis.

4. RESULTS AND DISCUSSION

4.1 Types of Location of the HCEs

The number of HCEs is highly concentrated in the northern part of the city. One of the largest public medical college hospitals of Bangladesh; Rangpur Medical College Hospitals (RMCH), is also located in the north. All of the clinics, pathology, diagnostic labs and dental clinics surveyed were private, while 21% of the hospitals were public and 79% private.

Fig. 1 shows the types of location of the surveyed HCEs in RCC. A large number of the HCEs, (42%) were located in the main city area, while 6% were located in industrial areas, 19% were located in commercial areas and 33% were located in mixed use areas (residential coexisting with government and private sector commercial activities). A few of the HCEs (2%) were located in the government allocated area.

Rangpur is a newly growing city. Expansion of the city is limited due to proper planning. Commercial buildings are predominantly built and managed by the private sector, and mixed use for developments, such as shopping malls and residential complexes, are popular. A large number of the private HCEs are established in residential areas, or within shopping malls. Senior management and owners of the HCEs indicated, through informal interviews, that they have established their activities in residential areas to maximize convenience for their patients; as most people have no private transport, and there is no free ambulance service. HCEs established in residential areas allow easy and timely access in an emergency. As there is a lack of legislation by the city authority, HCEs are allowed to dispose of their hazardous medical waste into general city corporation waste containers intended for domestic waste. This leads to mixing of medical waste and domestic waste, resulting in all waste becoming hazardous. However, it was identified during the interview that management did not consider the health and safety issues for the residents of the risks of medical waste and some of them were not interested in discussing this issue.

4.2 Types of Establishment Structure

When preparing the study area plans it became obvious that small and medium sized HCEs were generally situated with limited space within densely populated residential areas. No external storage was found in any of the surveyed HCEs. Of the surveyed HCEs, only 3% were located in an enclosed site with more than one building while 13% were housed in a single dedicated building, and 24% were located in a shared building, 27% were located in a single floor and 36% were located in a shared floor in RCC.

All of the HCEs located in a single building or a shared in a building or floor were privately owned or rented. In some of those facilities examined, the space required for even basic provision for proper waste segregation, storage and disposal would significantly reduce the number of beds or tests that the facility could support and so reduce profitability. Thus most HCEs have insufficient space to setup secured temporary storage for waste, or to install appropriate equipment for decontamination or final disposal of hazardous waste.

It was observed that none of the HCEs have an Effluent Treatment Plant (ETP) suitable for highly contaminated liquid waste. HCEs located in a single building discharged liquid waste directly to the municipal general sewerage system, and HCEs located on shared floors in a building discharged liquid waste into the building general sewerage. It was also found that some HCEs discharged liquid waste into adjacent canal (*Shema Sundori*) and water bodies that were also used by local residents for washing and household purposes, as well as for agriculture. At present HCEs liquid waste is discharged to the domestic septic tank, general sewerage system or connected directly to the public sewage network. As liquid waste and wastewater were not being treated appropriately, the discharge may lead to potential contamination of drinking water supplies, ground water contamination and/or environmental degradation.

During formal and informal interviews, respondents from management of the surveyed HCEs indicated that this was not done due to lack of space; also most of them did not have a positive attitude towards establishments of ETP. None of the HCE owners or managers was found to have considered waste management when establishing their business. Interviews with academics indicated that this was not due to the unwillingness of the architect or engineer, but due to the unwillingness of the HCE owner and management.

4.3 Manpower of the HCEs

It was found that the percentages of the doctors and nurses are more or less similar while office staff is the highest. Surprisingly the cleaners who are responsible for waste collection and management was found to be lowest in the surveyed HCEs (7%). This result could be illustrated that why the medical waste is not managed properly. It is obvious that the HCE owners and senior officials are not fully interested to manage the waste properly. Therefore, they are not concerned to recruit or involve designated person for particularly waste management issue. In some case, it was found and observed during the survey that the person who are responsible for office work are also responsible for waste management. In addition some of the cleaners are responsible for other purposes such as laundry work, kitchen work and patient service. Some of the junior nurses are also responsible for waste management was found in a number of HCEs.

4.4 Source, Composition and Generation of Waste in the Surveyed HCEs

Table 1 and Table 2 shows the waste generation, composition and the rate of the surveyed HCEs in the RCC. The data shows from that the out of generated total waste (1521 kg/day) highest percentage 75% of the generated waste is non-hazardous while 25% is hazardous and clinical waste in nature.

Table 1. Waste generation rate in the surveyed HCEs

Category of waste	Generation of waste(Kg)
General	1150(76%)
Pathological and infectious	80(5%)
Radioactive	1(0.065%)
Chemical	55(3.6%)
Sharps	65(4%)
Pharmaceutical	75(5%)
Plastic	95(6%)
Unclassified	(4.335%)
Total	1521(100%)

It was found from the survey that most of the waste volume is from kitchens in both hospitals and in clinics providing food services for patients. However, in the pathology/diagnostic centres, the main contributors to medical wastes are from the laboratory and research sections. This difference is probably due to the fact that these non-residential facilities do not produce a high volume of non-hazardous waste as a result of non-medical patient care, and so the medical waste is seen to be a higher percentage of the total.

4.5 Segregation System Used in the Surveyed HCEs

Table 3 and Table 4 show the current status of existing management system of medical waste in the surveyed HCEs of RCC area.

Most of the HCEs collected their waste without any management in the city corporation area. However, a number of surveyed HCEs used a partial segregation (segregated but mixed with hazardous and non-hazardous) procedure. Only 7% follows proper management procedures.

This study described the quantification of medical wastes generated from different HCEs and existing practice related to risks in the RCC area. The collected data showed that all the surveyed HCEs generate both of hazardous and non-hazardous waste including pathological, syringes, sharps and glasses, textile stained with blood and papers, chemical, pharmaceuticals, infectious and left over food.

Individuals working with medical waste frequently face the risk of occupational exposure to hazardous waste. Many scholars suggests that waste management workers who handled hazardous medical waste are especially at risk of communicable diseases like diarrhea and dysentery, blood-transmitted infectious diseases, gastroenterological, respiratory and skin infections [9]. Presented data indicates that there might be growing health risks in the study area because of rapidly expanding HCEs and growing number of individuals working with medical waste.

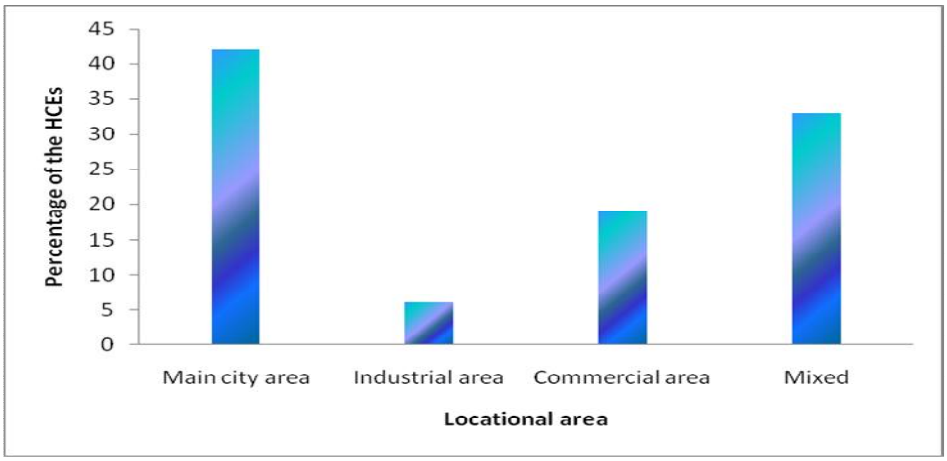

Fig. 1. Types of location of Surveyed HCEs in the RCC

Table 2. Waste generation in the surveyed HCEs

HCEs	Size of HCE		Waste generation rate		
	Beds	Test/day	Kg/day (%)	Average Kg/bed/day	Kg/test/day
Private hospital	225		338(50.75)	1.50±.02	
Clinic	162		243(36.48)	1.50±.02	
Pathology/diagnostic	0	1106	85(12.76)		0.50±.02

Table 3. Management practice of the surveyed HCEs

Establishment structure	Health care establishment				
	Hospitals (%)	Clinics (%)	Pathology/Diagnostic (%)	Dental (%)	Total (%)
Proper	9%	8%	10%	16%	12%
Partial	40%	59%	32%	28%	36%
Without	45%	38%	60%	56%	52%

Table 4. Segregation system practice of the surveyed HCEs in RCC area

Establishment structure	Health care establishment				
	Hospitals (%)	Clinics (%)	Pathology/Diagnostic (%)	Dental (%)	Total (%)
Proper	6%	18%	12%	3%	7%
Partial	42%	45%	26%	22%	30%
Without	51%	36%	61%	78%	63%

Hazardous waste containers can capable of nosocomial diseases transmission in individuals who are exposed to them [10]. In the survey area, most of the HCEs stored infectious sharps containers in general utility area without any proper labelling or other precaution. Cleaners and waste collectors in most of the HCEs usually did not wear sufficient protective uniforms during waste handling which circumstantially increases the risk of accidents. A small proportion of waste workers indicated that they have heard about the protective uniforms, but never had seen them. They stated through in-depth interviews that they are not aware of such hazards or associated risks from needles or sharps related accident.

RCC waste operatives are involved in a range of activities such as collection, transportation, operation/treatment of processing systems and final disposal of wastes. Potential risks to their health (RCC individuals) arising from medical waste have not been considered. Therefore, most of the waste management workers of RCC have experienced accidental injury mostly from used needles and other sharps.

5. CONCLUSION

The various functions of activities with medical waste in the HCEs and study area were thoroughly surveyed and studied. The present medical waste management in the surveyed HCEs is unsafe in point of in-house management such as; collection, segregation, storage, transportation, treatment and final disposal. In the study area present medical waste disposal environment may be a risk for the environment and community as well as to public health aspects. This is now a very emerging concern for the Rangpur City Corporation area as a newly develop city in a developing country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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