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Waste Management System in a Private Medical College Hospital, Bangladesh

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Abstract: Medical waste is potentially infectious waste materials generated at different health care institutes. The present study was undertaken to evaluate the medical waste management system, practices and to determine the amount of waste generated at a privately organized medical college hospital, Prime Medical College Hospital (PMCH), Rangpur. The survey and observation was conducted on eight wards of PMCH. This survey-based research was conducted to collect information on the practices related to waste segregation, collection procedures, temporary storage procedure, on-site transport and primary dumping point, treatment of wastes, off-site transport and final disposal options. In addition, the amounts of essential gases viz., O_2, CO, CO_2 was also measured at different sites of waste disposal point.

The study shows the highest amount of total wastes 108.95kg per day generated in gynae ward 1, and the lowest is 58.22 kg per day in medicine male ward. The highest average amount of general waste generated per day per bed is 1.98±0.06 kg in gynae ward 1 and the lowest 1.65±0.08 kg per day per bed in urology ward. But, the highest amount 0.40±0.03kg of medical waste generated in gynae ward 2 and the lowest amount 0.20±0.03kg in gynae ward 1 per day per bed. The overall percentage of general and medical waste generated in eight wards of PMCH is 85.47% and 14.53% respectively. The study observed that segregation of all wastes is not conducted according to consistent rules and standards. In most cases, medical waste is disposed of with domestic wastes. As medical wastes pose a significant impact on health and environment. This study suggests urgent need for raising awareness and education on medical waste issues.

The observation shows the mean amount of oxygen was 20.49ppm in the air on the disposal site, 20.63ppm in the air on 100 meter away from disposal site and 20.76ppm at distant place of disposal site. The amount of carbon monoxide is nil in the air. The mean amount of carbon dioxide is 448.27ppm in the air on disposal site, 467.23ppm on 100 meter away from disposal site and 451.45ppm in the air in at distant site. The present observation reveals the increase of atmospheric CO_2 by 12.5% in last few decades.

Key wards: Waste management, medical waste, health awareness, hazardous, air gases.

Introduction

Waste is unwanted or unusable materials. Waste is any substance which is discarded after primary use, or is worthless, defective and of no use. A by-product by contrast is a joint product of relatively minor economic value. A waste product may become a by-product, joint product or resource through an invention that raises a waste product's value above zero.

Medical waste is potentially infectious waste materials generated at health care facilities, such as hospitals, clinics, physician's offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories.

Different types of medical wastes are produced in hospitals. These wastes are very much different from household wastes. Without proper management of these waste public health falls in great risk. Medical wastes are in little in amount in comparison to community wastes but very much potential regarding healthcare. They are not only hazardous to community but create much risk to public health. Improper disposal of medical waste including open dumping and uncontrolled burning increases the risk of spreading infectious diseases. The proper management of these wastes are very much essential.

In many countries of the world, it draws the major attention. But in developing countries, like Bangladesh medical waste management has not received sufficient attention. This is because, very often, health issues compete for the very limited resources. Even now, hazardous and medical wastes are still handled and disposed together with domestic wastes, thus creating a great health risk to municipal workers, the public and the environment (WHO, 2018).

Of the total amount of waste generated by health-care activities, about 85% is general, non-hazardous waste. The remaining 15% is considered hazardous material that may be infectious, toxic or radioactive. Every year an estimated 16 billion injections are administered worldwide, but not all of the needles and syringes are properly disposed of afterwards. Medical wastes are infectious and hazardous. It poses serious threats to environmental health and requires specific treatment and management prior to its final disposal (Hossein *et al.*, 2011**).** Medical wastes are arising from diagnosis monitoring and preventive, curative or palliative activities in the field of the veterinary and human medicine (BAN & HCWH, 1999). The recent developments in healthcare units are precisely made for the prevention and protection of community health. Uses of sophisticated instruments are increasing various

operations for diseases treatment. Such improvement and advances in scientific knowledge have resulted in per capita per patient generation of wastes in healthcare units (Radha *et al.*, 2009). Medical waste is a source of contamination and pollution to both humans and the environment. Medical waste is capable of causing diseases and illnesses to people, either through direct contact or indirectly by contaminating soil, groundwater, surface water and air (PRISM Bangladesh, 2005). Wind from these dumps can also carry pathogens and hazardous materials. Where domestic animals are allowed to graze in open dumps, there is a risk of reintroducing pathogenic microorganisms into human body through food chain. Medical waste therefore, poses a risk to individuals, communities, and the environment if not carefully handled (Akter *et al.,* 1998). Health-care activities protect and restore health and save lives. But what about the waste and by-products they generate?

Hospitals and clinics are health institutions providing patient care services. It is the duty of hospital and healthcare centres to take care of public health. In the process of healthcare delivery, waste is generated which includes sharps, human tissues or body parts and other infectious materials. Medical wastes represent a small amount of total residues generated in a community. However, such residues can potentially transmit diseases and present an additional risk to the staff of the healthcare facilities, patients and the community when the wastes are not managed properly. Improper disposal of medical waste including open dumping and uncontrolled burning for instance increases the risk of spreading infections and of exposure to toxic emissions from incomplete combustion. The safe disposal of medical waste has been ignored in Bangladesh.

Very recent, primary observational study on three government medical college hospitals in Bangladesh at three different districts has done (Haque *et al.,* 2021a, b). Little earlier the same observational study was conducted by Rahman *et al*., (2013) and Moniruzzaman *et al*., (2018) in Jessore and Khulna City. The present study was conducted to explore the present practices, assessment of waste disposal in Prime Medical College Hospital, Rangpur, a private sector hospital, and to recommend the effective method of waste management. In addition, some important healthcare related air gases like, O_2, CO and CO_2 amount has also been measured at different place of waste disposal site.

Aims and objectives of the research

The principal objective of the study is to estimate the amount of medical waste in Prime Medical College Hospitals, presence of air gases at different places of the disposal sites. This was also in mind to study the type of management system used for these medical wastes and to suggest guidelines for safe handling and management system of medical waste. To attain this objective the study was designed to:

Survey and identify the different types of medical wastes generating from this hospital.

Characterization of the wastes in different categories on the basis of internationally acceptable definition of the wastes.
On the basis of the category, assessment of the different wastes disposed off from the major wards of the hospital and possible amount/quantity/day.
Study the generation of air gases from wastes that are disposed off outside hospital.
Provide recommendations and guide lines on methods to handle medical wastes with a minimum impact to human health and the environment.
To organize short training and workshop with the personnel related to waste management and the research students.
On the basis of categories to recommend a management system of the wastes.

Methodology

The study was conducted to approximate the quantity of medical waste in different wards at Prime Medical College Hospital (PMCH), Rangpur. Presence of air gases on the disposal sites was also mind to the method of waste management system used for medical waste and suggest for safe handling and management of healthcare waste. To attain the goal of this, the study was designed to:

collect information on the waste, treatment, handling and disposal wastes at Prime Medical College Hospital.
survey and identify the different types of waste generating from the hospitals.
investigate what problems the hospital encounters in managing medical waste.

The methodology of this study comprises of field level observation and data collection through survey with questionnaires (Haque *et al*., 2021a), inventory & personal interviews in formal and non-formal ways. The observation was conducted on eight different wards viz. Child ward, Gynae ward 1, Gynae ward 2, Medicine male, Medicine female, Gastroenterology, Urology ward and Surgery ward of PMCH. Before entering in to the hospitals, the research group was trying to get permission from hospital authority.

The selected wards were visited in scheduled days, the wastes were segregated according their types and weighed. During the observation period sufficient time was allotted to get information from the waste collectors, nurses, cleaners, ward master to develop the report.

In this research, methodology was appropriated following the method used by Oweis *et al.*, (2005). For this two-stage strategy was included:

Surveying the procedures, rules and regulation from the hospitals glossary that followed by the personal concerning the waste management produced at PMCH.
In selected wards of the hospitals, the amount of waste generated was segregated, weighed and recorded.
Observation was also conducted on critical manner about the management and practices of medical waste by the waste collectors.

The number of beds in different wards, and number of patents present on that day in different wards were also recorded. Secondary data were also collected from the hospital documents. Some authorities, doctors were also interviewed for collecting information. The questionnaire and data form, slightly modified, was based on the suggest of the WHO for assessment of healthcare waste management in developing countries (Haque *et al*., 2021b, Pruss *et al.,* 1999, WHO, 1999).

The research team started to work from July 2019, conducted some pilot observation, met with different authorities, done interviews. They collected wastes from different wards from August 2019 to January 2020.

In addition, amount of three important gases, viz., O_2, CO, CO_2, in the air at different sites of the waste disposal place, was also measured by digital gas meter. The selected sites were disposal site (DS), 100 meter away from disposal site (100DS) and long distant from disposal site (LDS).

Data Collection Tools: The wastes were firstly categorized into general and medical wastes. The medical wastes were again classified into chemical, infections, sharps, pharmaceuticals and other medical. Data were collected using four instruments (questionnaire, site visiting, electric devices and in-depth interview.

Data Analysis: Collected data were analyzed very carefully. In different days of the study period, the amounts of different types of waste generated at different ward of the said wards of the hospital was measured and noted.

Result and Discussion

The average amount of waste per day and amount per day per bed of eight different wards of Prime Medical College Hospital (PMCH) are calculated and presented in Table 1 & Table 2. The study shows the highest amount of total wastes 108.95kg per day generated in gynae ward 1, where patient number is 55 and the lowest is 58.22 kg per day in medicine male ward where the patient number is 32 (Table 1). Table 2 reveals the highest 1.98±0.06 kg of general waste per day per bed is generated in gynae ward 1 and the lowest 1.65±0.08 kg of general waste per day per bed in urology ward. But, the highest amount 0.40±0.03kg of medical waste generated in gynae ward 2 and the lowest amount 0.20±0.03kg in gynae ward 1 per day per bed.

Table 1. Average amount different waste per day in different wards of Prime Medical College Hospital, Rangpur.

Ward	Bed	Bed	General	Chemical	Infectious	Sharps	Pharmaceuticals	Others medical	Total
Child ward	**40**	**Average**	**22.38**	**3.26**	**1.96**	**1.08**	**1.87**	**1.26**	**71.73**
		STD	**1.90**	**0.61**	**0.49**	**0.24**	**0.25**	**0.35**	**2.24**
Gynae ward 1	**55**	**Average**	**43.11**	**3.21**	**2.40**	**1.33**	**1.94**	**1.97**	**108.95**
		STD	**2.89**	**0.64**	**0.60**	**0.47**	**0.34**	**0.74**	**3.41**
Gynae ward 2	**42**	**Average**	**41.00**	**3.23**	**4.52**	**2.14**	**1.70**	**5.05**	**99.63**
		STD	**1.35**	**0.60**	**0.66**	**0.35**	**0.50**	**0.60**	**1.65**
Medicine M	**32**	**Average**	**16.99**	**1.90**	**2.07**	**1.33**	**1.85**	**2.10**	**58.22**
		STD	**2.36**	**0.23**	**0.29**	**0.30**	**0.39**	**0.39**	**2.56**
Medicine F	**32**	**Average**	**17.26**	**1.94**	**2.12**	**1.33**	**1.91**	**2.12**	**58.68**
		STD	**2.93**	**0.33**	**0.24**	**0.30**	**0.45**	**0.40**	**3.45**
Gastroenterology	**35**	**Average**	**16.34**	**1.94**	**2.12**	**1.33**	**2.10**	**2.12**	**60.95**
		STD	**3.43**	**0.33**	**0.24**	**0.30**	**0.28**	**0.40**	**3.91**
Urology ward	**40**	**Average**	**16.72**	**2.00**	**2.11**	**1.33**	**2.05**	**2.12**	**66.78**

		STD	**2.82**	**0.31**	**0.26**	**0.30**	**0.19**	**0.40**	**3.95**
Surgery ward	**50**	**Average**	**41.68**	**5.16**	**2.14**	**2.14**	**2.15**	**1.77**	**105.03**
		STD	**1.74**	**0.66**	**0.35**	**0.35**	**0.33**	**0.41**	**1.80**

Table 2. Average amount of general and medical waste per bed per day in different wards of Prime Medical College Hospital, Rangpur.

Ward Name	Bed	Gen /bed	Med/bed
Child ward	**40**	**1.79±0.06**	**0.23±0.02**
Gynae ward 1	**55**	**1.98±0.06**	**0.20±0.03**
Gynae ward 2	**42**	**2.37±0.04**	**0.40±0.03**
Medicine M	**32**	**1.82±0.08**	**0.29±0.02**
Medicine F	**32**	**1.83±0.11**	**0.29±0.03**
Gastroenterology	**35**	**1.74±0.11**	**0.27±0.03**
Urology ward	**40**	**1.65±0.08**	**0.24±0.02**

The percentage of general and medical waste in the above mentioned eight wards is shown in Fig. 1. The overall percentage of general and medical waste generated in eight wards of PMCH is 85.47% and 14.53% respectively.

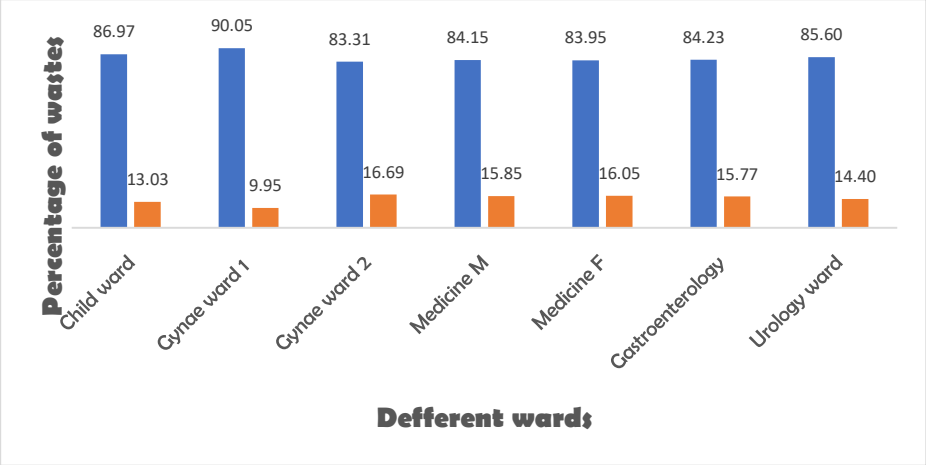

Fig. 1. Percentage of general and medical waste in different wards,

The Atmosphere has two main components: nitrogen (78%) and oxygen (21%). These make up 99% of the volume of "dry air". Oxygen: is the most important and it is removed from atmosphere by decaying organic matter combining with other substances, or is taken in during breathing. On the other hand, it is added to the atmosphere through photosynthesis by plants.

Carbon Dioxide is the second most important greenhouse gas on the earth atmosphere. Carbon Dioxide enters the atmosphere through the decay of vegetation, volcanic eruptions, respiration, burning of fossil fuels, and from deforestation. On the contrary it is removed

from the atmosphere by photosynthesis, and the oceans. Concentration has been increasing due to human activities, mainly burning fossil fuels and deforestation.

The presence of air gases O_2, CO, CO_2 at different places of waste disposal site of PMCH was measured and the mean value is presented in **Fig. 2**.

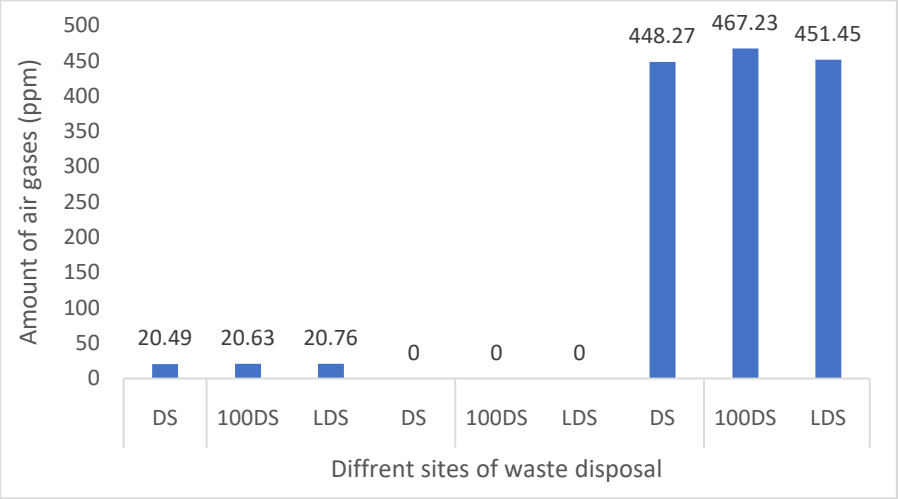

Fig. 2. Amount of air gases at different points of disposal sites of PMCH.

The gases were measured from disposal site (DS), 100 meter away from disposal site (100DS), long distant from disposal site (LDS). The amount of gases was measured with oxygen meter, carbon dioxide meter, and carbon monoxide meter. The observation shows the mean amount of oxygen was 20.49ppm in the air on the disposal site, 20.63ppm in the air on 100 meter away from disposal site and 20.76ppm at distant place of disposal site. The amount of carbon monoxide is nil in the air. The mean amount of carbon dioxide is 448.27ppm in the air on disposal site, 467.23ppm on 100 meter away from disposal site and 451.45ppm in the air in at distant site.

The amount of carbon dioxide has increased over 42% since 1750, from 280 ppm to 400 ppm. There is concern that this will strengthen the natural greenhouse effect leading to global warming, sea level rise, and other potentially harmful climate changes. The present observation reveals the increase of atmospheric CO_2 by 12.5%.

The World Health Organization defines healthcare waste as the total amount of waste from hospital establishment, research facilities, lab and emergency relive donations (WHO, 1999). Different techniques have been used all over the world to estimate amount of healthcare trashes. They included the use of physical finding, questionnaire authority and quantification (Olubukola, 2009; Phengxay *et al.*, 2005). Recent research in African country has estimated that about 0.657 to 0.760 kg/bed/da**y** waste generated (Longe and Williams, 2006).

Rahman *et al.*, (2013) made an observation on waste generation of in one public hospital, twelve private hospitals and clinic and seven diagnostic centres of Jessore municipality area of Bangladesh. Their findings particularly focused on the average generation rate of the studied health care institutes. The generation rate in public hospital was 2.02 kg/ bed/ day,

0.49 kg/patient/day and 0.133 kg/test/day. The generation rate was 1.36 kg/bed/ day, 0.54 kg/patient/ day and 0.086 kg/test/day and 0.33 kg/patient/day and 0.168 kg/test/day in private clinic and diagnostic centre respectively. They found unsatisfactory management practice on the basis of environmental safety. They observed inadequate amount of selected colored dust bin, regular monitoring, arrangement of training, regular assessment of health care institute by government through the specialist, implementing of rules and regulations. Moniruzzaman *et al*. (2018) studied the waste management system in six hospital hospitals in Khulna city. They reported that the average generation rate of different categories of hospital waste such as general waste, anatomic waste, pathological waste, chemical waste, pharmaceutical waste, infectious waste, sharp waste and liquid waste were 0.138, 0.0028, 0.0091, 0.0036, 0.0009, 0.0334, 0.036 and 0.0205 kg/day/bed, respectively. They also showed that there was no radioactive waste in the selected hospitals of Khulna. According to their comment, the improper segregation, lack of treatment, consciousness and financial support are liable for inappropriate management. Finally, they proposed a management system for segregation and storage by selected colored container, proper collection, safe transportation, proper treatment and disposal for improving existing system. They also suggested the regular monitoring and assessment of hospital waste by hospital and city authority for a safe and healthy environment.

Bhuiyan (1999) reported that one of the clearest impacts of rapidly increasing urbanization and economic development can be witnessed in the form of the help of municipals solid waste. In the Asia-Pacific region, waste management has become an important issue, and it is essential to be resolved through an integrated community, private-sector and policy base approach. Bangladesh being a member of Asian Productivity organization that manage with a survey on waste management practices and to highlights issue, problems and the initiatives undertaken to equipment them.

The amount of medical waste is a very little fraction, about one percent of the total amount of general wastes generated in Bangladesh (World Bank, 2002). But when this little amount of infectious waste in not controlled properly, it gets mixed with household general waste, and the whole waste become infectious and that waste become dangerous for environment and health risk. Until recent past, there was no standard system for medical waste management in Bangladesh. Bangladesh government is trying to develop a system to control a standard medical waste management system.

The finding of the research study revealed that the Prime Medical College Hospital partially follows the standard for colour coding segregation and treatment of system. PRISM Bangladesh controlled the waste management of Prime Medical College Hospital. The Hospital authority and PRISM Bangladesh tries to follow WHO requirements, and to maintain the standard guideline. But even now, the staff of Prime Medical College Hospital have poor awareness about the waste collecting and disposing method. Some of the waste collectors use safety mask but most of them are not wear the masks. It has been noticed that

most of the waste collectors do not use hand gloves, boot and safety cloths. Sometimes waste collectors carrying waste in the bucket or tubs.

The standard guideline of the waste collectors from all hospital should carry waste by trolley but often they carry waste in their own hand without hand gloves. Therefore, the standard medical waste management practice is very important all hospitals. But most of the hospital staff are not properly trained and maintain minimum guideline. Moreover, the number of waste management staff is inadequate. Arrangement of seminars and workshops with hospital waste collector's staffs, proper training regarding the medical waste management can improve the waste management system in hospitals.

For standard segregation and colour coding, the hospital authorities should follow the WHO guideline. PRISM Bangladesh controlled the treatment and disposal of medical waste of Prime Medical College Hospital. They use incineration method for treatment. They incinerate medical waste only one day per week. They will try to follow WHO recommendation properly. Therefore, the Prime Medical College Hospital should try to improve their waste management system.

Recommendations

In the light of above observations, a number of recommendations are made thereby with the hope of improving the medical waste management system in Bangladeshi hospitals. The following recommendations could enhance the operating efficiency of the hospital's waste management:

It is important to quantify the amount of medical waste generated in each unit of the hospital periodically.
Proper segregation of infectious medical waste & non-infectious medical waste.
The provision of strong plastic container for infectious waste such as empty containers of antiseptic used in the hospital is necessary.
Bags and container for infectious waste should be marked with bio hazard symbol.
A standardized system of red colour coded bag used for the segregation of risky waste should be used and rigidly followed.
The hospitals should institute an efficient management system, including proper equipment & containers for collection, transportation, treatment and final disposal.

The hospital should institute regular training & education of all workers, from doctor to word boy, laborer, rag pickers.
Environment health experts must be included in the waste management team.
The hospital should formulate a medical waste management policy.
The hospital must set a sub-committee to be responsible for medical waste management in the hospital. The sub-committee should be in charge of periodic reviewing and resolving medical waste management issues in the hospital. The sub-committee should also monitor closely the activities of the private waste management company to ensure that they perform their duties as expected.

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