

**Hospital Waste Disposal in Bangladesh
with Special Reference to Dhaka City
and its Environmental Evaluation**

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December 1998

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Published as "Medical Waste Disposal in Dhaka City: An Environmental Evaluation". Publisher International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). Special Publication No. 87. February 1999.

Abstract

The increased number of clinics and hospitals in Bangladesh resulting in the increased amount of waste generation. Hospital waste contains toxic chemicals and hazardous materials from several diagnostic and treatment processes. The improper disposal of hospital waste in the country poses a high health risk to humans as well as the environment. The improvement of waste management in clinics and hospitals is essential to minimize the spread of infectious diseases. The Association for Rural Development Studies (ARDS), in collaboration with BRAC, has undertaken this study to formulate guidelines and recommending a safe handling system of hospital waste in Bangladesh. A survey was conducted on the characteristics of hospital waste and the present practice of hospital waste management in 38 hospitals and clinics in Dhaka, Mymensingh and Dinajpur. The results revealed that the present waste disposal system was unhygienic and unsafe. The knowledge level of hospital staff on the harmful impacts of improper waste disposal was also very low. The need for raising awareness, improving waste handling and disposal system, and implementing laws and regulations regarding hospital waste management are recommended.

INTRODUCTION

BACKGROUND

In Bangladesh, wastes generated in most urban and rural areas are disposed of by open dumping in either low depressions or high areas for natural degradation. As a result the soil underlying the waste is contaminated by pathogenic microorganisms, heavy metals, salts, and chlorinated hydrocarbons. The wastes are also known to clog sewers and open drains, encroach roadways, diminish landscape aesthetics and give unpleasant odours and dust (1). Little regard is given to the location of the dump and many are found next to residential areas.

The safe disposal of Medical waste has been ignored in Bangladesh. 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. 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 (2).

There has been little research done on Medical waste disposal in Bangladesh. A survey, conducted by Rashid *et. al.* (3) on Medical Waste Disposal in Dhaka City, found that the government hospitals placed all waste in open dustbins for up to two days. Other hospitals left their waste outside in open dustbins for two to three days before a municipal truck would remove them. At the orthopedic hospital parts of human bodies were also found in dustbins. Medical staff was found to generate revenue through sale of Medical waste. Used syringes and other medical and clinical waste were sold for Tk. 20/kg at most hospitals and clinics visited. Rashid (3) concluded that there was a lack of knowledge and interest in safe waste disposal by most health workers and an absence of a budget to effectively implement safe waste disposal. Kazi (4) also conducted a study on hospital waste in Dhaka and recommended several steps to

improve hospital waste management in Bangladesh.

Akter *et al.* (2) conducted a study on Medical waste disposal at BRAC Health Centres. The findings indicate that there was a lack of awareness, concern, and knowledge on disposal of Medical waste not only at BRAC health centers but also at the government hospitals, private laboratories, and private clinics. Medical waste disposal systems in both the government hospitals and private clinics were severely unhygienic.

Bangladesh lacks both effective waste management facilities and relevant government policy to guide health providers and punish offenders. A major problem in implementing a waste management programme for Medical waste is that any planned change in the collection or disposal systems is likely to be sabotaged by the informal sector.

One estimate shows that some 5.2 million people (including 4 million children) die each year from waste-related diseases in Bangladesh (5). The amount of municipal waste globally is predicted to be double by the year 2000 and quadruple by 2025 (5). Concerned with this situation Agenda 21, adopted in the UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, set the following goals with regard to waste management in cities:

- All countries must establish waste treatment and disposal criteria and develop the ability to monitor the environmental impact of waste by the year 2000,
- By 2025, developing countries should ensure that at least half of the sewage, wastewater and solid waste are disposed according to national and international guidelines.
- By 2025, all countries shall dispose of all waste according to international quality guidelines.

The Government Environmental Policy of 1992 has six general aims, which have been further detailed into priority objectives for different sectors. These objectives are as follows:

- Prevent activities which are harmful to public health in all spheres, including development activities

in the country,

- Integrate environmental concerns into the national health policy,
- Incorporate environmental issues in health education curriculum, and
- Ensure a healthy workplace for workers.

Although there is no specific clause in the Environmental Protection Act 1995 pertaining directly to the handling, transportation or disposal of Medical waste. In Bangladesh, Medical waste can be classified under Section 2(1) which defines waste as “any liquid, solid and radioactive substance that is discharged, disposed, or dumped which may cause adverse/negative change to the environment.”

Objectives of the study

The objectives of this study were to assess the level of knowledge on Medical waste, to look into the Medical waste disposal system, assess the effects of Medical waste on health and environment, and to suggest guidelines for safe handling of Medical waste. To attain this objective the study aimed to:

- Know the level of awareness of the people related to medical services regarding Medical waste.
- Identify the potential impacts that Medical wastes pose to both humans and the natural environment.
- Assess the health and environmental risk of Medical waste (such as: chemicals used in laboratory, pathogenic organism)
- Provide recommendations and guide lines on methods to handle Medical wastes with a minimum impact to human health and the environment.

MEDICAL WASTE: AN OVERVIEW

Characteristics of medical waste

Table 1 shows the types of medical waste according to Eigenheer & Zanon (6). They classified medical waste according to their liquid and solid state.

Table 1. Types of medical wastes

Type	Typical examples
Liquid Wastes	
Biological waste	Blood, excrement, body fluid etc.
Chemical waste	Solutions, inorganic salts etc.
Over-date medicines	Unused drugs, over-date drugs
Radioactive waste	Wastes from radiology (iodine 125, iodine 131 etc.)
Solid Wastes	
Perforating and cutting wastes	Needles, syringes, scalpels, blades, broken glass, vials
Non-perforating and non-cutting wastes	Wastes from treatment (dressings, stool napkins, plaster cast etc.) Parts of the body: organs, placentas, tissue etc. Over-date medicines (Expired drugs) Household-type wastes: other wet and dry waste

Medical wastes are also classified into four different categories based on sources and the potential

hazards they may cause. Such as,

- a) **Clinical waste:** Clinical waste includes body fluid, drainage bags, blood collection tubes, vials, culture dishes, other types of broken/unbroken glassware that were in contact with infectious agents, gauze, bandage or any other materials that were in contact with infectious agents or blood, pathological waste including organs, body parts, tissues. These are potentially dangerous and presents a high risk of infection.

- b) **Laboratory waste:** Laboratory waste is also of high risk category. This includes chemicals used in the pathological laboratories, microbial cultures, and clinical specimens, slide, culture dish, needle, syringes, as well as radioactive waste such as iodine-125, iodine -131, etc.

- c) **Non-clinical waste:** Wrapping paper, office paper, and plastic that have not been in contact with patient body fluid are the examples of non-clinical waste.

- d) **Kitchen waste:** Kitchen waste includes food waste, dirty water, etc. It is also a potential source of pests and vermin, thus creates an indirect hazard to staff and hospital patients.

Existing practice of Medical waste disposal

Waste is collected from a small bowl or bin, kept under each bed in a hospital or a clinic and then either in a large plastic bag or a (plastic or metal) bucket. With a push cart these wastes are then carried to the nearest municipal bin for dumping. The municipal bins are either within hospital premises or outside the hospital. Waste from operation theaters, laboratories and hospital kitchens are also dumped into the same municipal bins. This waste is then collected from municipal bins by trucks and carried to the landfill area for final disposal.

Risk associated with improper disposal of Medical waste

Medical waste usually consists of clinical and non-clinical waste. Such pollutants can, therefore, be

broadly classified into solid wastes, and liquid waste (wastewater). Both are important sources of environmental degradation and constitute a health hazard. For example the soil on which waste is dumped is a reservoir of microbial life. Also waste-contaminated water contains pathogenic micro-organisms which can cause many diseases.

Solid waste refers to non-liquid wastes or 'refuse'. It includes dust, ash, food waste, rags, paper, plastic, glass, metals, radioactive and pathological wastes. Liquid waste contain chemicals used in laboratories, pathogens containing urine, blood and other sample for testing disposed off to the wastewater.

Waste attracts scavenging animals and bats. As it ferments it gives foul odors, favours fly feeding and contaminates both water and air. During decomposition waste generates several gases, the most important among which are methane (CH₄), nitrogen (N₂) and occasionally hydrogen sulphide (H₂S). If burnt, carbon di-oxide (CO₂) is released. Methane and carbon di-oxide are greenhouse gases and have potential greenhouse effects.

The total garbage generation in Dhaka city is 3,500 metric tonnes per day of which only 5.7% comes from medical establishments (7). Most hazardous and toxic other than domestic or industrial waste is clinical and medical waste which is disposed off in normal dustbin sparsely. There are over 500 clinics and hospitals in Dhaka city. Approximately 200 metric tonnes of medical wastes are generated in the city per day, 20% of this is infectious and hazardous (4). The Bangladesh Centre for Advanced Studies (BCAS) survey showed that hospital staff, neighbours and waste collectors were not aware of safe disposal of medical waste. Moreover, waste disposal practices were found to be quite unsafe as both clinical and non-clinical waste were thrown together.

Health hazards related to Medical waste

- (i) Injuries and accidents e.g. cut-injury, punctured wound, laceration, strain and sprain of the joint of limbs and backache due to load hauling.

ii. Infectious medical waste

Infectious hospital waste represents only a small part of total Medical waste. Yet, because of ethical questions and infection risks, it is a focal point of public interest. Infectious waste contains different kinds of pathogens or organisms that is potential for infection or disease if it is not properly disposed. Table 2 below shows few examples of different pathogen and diseases caused by them.

Table 2: Pathogen and diseases caused by those pathogen

Bacterial	Tetanus, gangrene and other wound infection, anthrax, cholera, other diarrhoeal diseases, enteric fever, shigellosis, plague, etc.
Viral	Various hepatitis, poliomyelitis, HIV-infections, HBV, TB, STD rabies, etc.
Parasitic	Amoebiasis, giardiasis, ascariasis, ankylostomiasis, taeniasis, echinococcosis, malaria, leishmaniasis, filariasis, etc.
Fungal infection	Various fungal infections like candidiasis, cryptococcoses, coccidioidomycosis, etc.

Infected hospital waste can transmit diseases, especially if it finds portals of entry. “There is strong epidemiological evidence from Canada, Japan and the USA that the main concern of infectious hospital waste is the transmission of HIV/AIDS virus and more often of hepatitis B or C virus (HBV) through injuries caused by syringes contaminated by human blood.” Other than these, there is potential risk of TB/throat infection, typhoid, dysentery, diarrhoea, dacterial/viral diseases, ARV (Rabies), Sexually transmitted disease, UTI/all C/S, Leprosy, etc. as the pathological laboratories do all these analysis to diagnose the diseases (2).

iii. Hazardous Medical waste

Hazardous Medical waste consists primarily of chemicals and discarded cytotoxin drugs. Some common

hazardous chemicals, some of which are probable carcinogens or pose other health risks and effects, are summarized in Table 3. This class of medical waste, while largely ignored poses risk to workers handling them.

Table 3. Types of chemicals used in medical facilities, pharmaceuticals industries, and their uses and effects (few available examples only).

Chemical	Purpose of Use	Properties	Potential effects
Xylene	Removal of seederwood oil for TB slides	Toxic	Inhalation of vapours can causes headaches, euphoria, light-headedness, dizziness, drowsiness, nausea Vapour can irritate skin, eyes, and lungs Over exposure can lead to irregular heart beat, fainting, and eventually death
Carbol fuchsin	Fixing of sputum slides	Corrosive Poisonous	Readily absorbed and can cause severe burning if brought into contact with skin/eyes/lungs Inhalation results in chest pains, increased heart rate, coughing, nose and throat irritation, convulsion, and eventually death
Phenol	Disinfectant and sterilizer	Corrosive Combustible Poisonous	can cause severe burning to skin, eyes or lungs if contacted can seriously affect lungs and respiratory system if inhaled (pulmonary oedema, lung inflammation) potentially fatal Ingestion causes nausea, vomiting, gastro-intestinal irritation and bleeding Over exposure can lead to kidney and liver damage
Hydrochloric Acid	Fixing of sputum slides	Corrosive Poisonous	May cause burning sensation if brought into contact with skin/eyes Inhalation causes coughing/restricts breathing and damage to upper respiratory system

Methylene Blue	Fixing of blood & sputum slides		Can cause damage if brought into contact with eyes, skin, clothing
Chemotherapy and Anti-neoplastic chemicals	Treatment	Hazardous Toxic	Carcinogenic Other health risk
Formaldehyde	Pathology, autopsy, embalming	Hazardous Toxic	Health risk Suspected carcinogens Eye, nose and throat irritation
Glutaraldehyde (fixer, developer)	Photographic (X-ray)	Hazardous Toxic	Health risks
Ethylene Oxide	Sterilizers	Hazardous Toxic	Harmful to health
Acid gases (e.g. HCl, NO _x , SO ₂)	Laboratory	Hazardous	Acute effects such as eye and respiratory irritation May enhance the toxic effect of heavy metals
Chlorine made material (e.g. PVC)	Laboratory	Hazardous	Creates dioxin Animal carcinogen and considered human carcinogen
PCBs(Polychlorinated biphenyls)	Medicine industries	Hazardous Toxic	Harmful to fish and other aquatic forms of life because they interfere with reproduction PCBs produce liver ailments and skin lesions in human In higher concentration, they can damage the nervous system, and are suspected carcinogens
Heavy metals (mercury, arsenic, and zinc, for example)	Instruments, treatment, Medicine industries	Toxic (neurotoxic)	Women and children are most vulnerable Have carcinogenic, mutagenic and teratogenic effects Exposure lead to pneumonitis, bronchitis, muscle tumor, irritability, gingivitis Nerve damage Enter to the food chain and concentrated In humans, these metal can produce kidney and liver disorders, weaken the bone structure,

			damage the central nervous system Cause blindness, and lead to death
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Source: Ref 1, 8, 9, and NWFSC MSDS Search;

METHODOLOGY

The sample

Thirty-eight government and private medicals and clinics, and diagnostic centers were purposively included in the study (Annex 1). Environmental examinations were conducted mainly in Dhaka city, with a few selected sites in Mymensingh and Dinajpur districts. These were selected as large, medium and small category as well as the type of services they rendered. A comprehensive investigation was made to see the waste disposal practices of 38 hospitals and diagnostic centres in Dhaka, Mymensingh and Dinajpur districts. These consisted of 11 private clinics, 13 diagnostic laboratories, and 14 government medical facilities. Government hospitals and clinics, and private laboratories and clinics were also visited in Mymensingh and Dinajpur. A government hospital, a private laboratory, and a health and family planning centre were visited in Mymensingh. Two private clinics, three government medical facilities, and a private laboratory were visited in Dinajpur. The remaining of medical facilities were visited in Dhaka.

Data collection

Data were collected through checklist, field observations, interview, and laboratory analysis during March 1997 - September 1998.

- (i) **Field observations:** Field observations were made at each location, using a checklist that focused on potential problems posed by disposal of Medical waste. Waste generation sites (ward, laboratory, kitchen), laboratory (sample collection site, place of analysis, washing basin), and waste disposal sites (dustbin, dumping site, drainage system, wastewater flow) were observed. Current waste management system and the safety measures taken in the pathological laboratory and clinics were also observed.

- (ii) **Interview:** Interviews were conducted with people involved in providing medical services and handling and disposing medical waste. At Dhaka, 22 directors or divisional heads of different institutes, 17 doctors and nurses, 17 laboratory technicians, 19 cleaners, and 17 garbage dwellers (*tokai*) were interviewed. Divisional heads, doctors on duty, and laboratory technicians were interviewed at Mymensingh and Dinajpur. Generally questions were geared towards the basic understanding of the respondents.

(iii) **Laboratory analysis:** Wastewater and solid waste from the drainage and disposal sites were collected for pathological (microbial) analysis, typhoid, tuberculosis, shigella, and diarrhoea. Samples were collected from dustbins where Medical waste was dumped and from hospital wastewater. Sampling sites are shown in Annex 2.

Limitations

Any study involving interviews and observations will be prone to biases. We have tried to maintain an unbiased outlook when collecting data and conducting interviews. During interviews some respondents tried to give us the answers they thought we were looking for, even if it seemed contrary to what other respondents in the same area said or what we observed.

There were difficulties in finding a laboratory to analyse waste samples. There is no advanced system in Bangladesh to analyse hospital wastewater or solid waste for chemicals or pathogens except few pathogens. It is difficult, therefore, to calculate the extent to which the results of the study may have been affected. In spite of these restrictions, the information presented in this report is believed to maintain a credible degree of precision in detailing the conditions and circumstances of handling medical waste.

FINDINGS

INTERVIEWS

Medical Care

Hospitals are classified according to the number of beds and number of patients visited each day (Annex 3). At Infectious disease hospital (TB hospital) there were 600 beds and Dhaka Medical College hospital has 800 beds. Sohrawardi Hospital has 300 beds but about 1000 outdoor patients visit each day, Ibrahim Memorial Diabetic Hospital (BIRDEM) has 546 beds and outdoor patients were 4000 in each day.

Most of the hospitals and clinics give medical care for all. Only a few hospitals give service for specific groups, e.g. Shishu (children) hospital, Dhaka ENT hospital.

Most of the hospitals have less than 20 doctors. There were only four hospitals in which the number of doctors ranges from 42-105. Some diagnostic centres or clinics have neither nurse nor cleaner.

Waste disposal

Different methods were used by the hospitals, clinics and pathological laboratories to dispose of waste. These included burning, burying, selling, dumping, re-use and removal by municipal trucks. It was found that slides were re-used, and no safety measure were undertaken by the laboratory technicians. Only soap and water were used for cleaning used syringes.

It was found that saline bags, water used in developing x-ray films, syringes, vials, slides, empty packets and bottles were collected and sold. Medical waste were collected by hospital authorities, cleaners, *ayas* and street archins and sold to hawkers and small traders. Table 4 shows the list of items and their selling prices at the Mymensingh Medical College Hospital.

Table 4 Price list of waste items sold by Mymensingh Medical College Hospital (as of 1997)

Item	Price
X-ray water	Tk 11.25/litre
Poly bag or jute bag	Tk 0.50/bag
450 ml bottle	Tk 1.50/piece
250 ml bottle	Tk 0.25/piece
100 ml bottle	Tk 0.10/piece
Saline bag (1000 ml - 500 ml)	Tk 20/kg
Ampoule or vial	Tk 2/kg

Syringes, plastic materials, paper, and cartons were gathered daily and burned monthly or after certain period at open pits in some hospitals or clinics. In most cases, there was no specific place for burning Hospital waste. Usually waste burning took place in open fields, hospital surroundings and/or outside hospital or behind the clinic facilities. In government hospitals soiled bed sheets and mattresses were burned on-site. Cleaners and sweepers were responsible for burning waste. Table 5 shows common modes of Medical waste disposal and Table 6 shows what items were disposed off in different disposal systems.

In some hospitals Medical wastes were buried near the medical facilities or within the hospital compound. In some hospitals, sweepers buried fetuses and placenta in soil near the rivers or the morgues. Most hospitals dumped different wastes together in a common place like roadside, hospital surrounding, and municipal dustbins. People handling Hospital waste were often cleaners, sweepers, ward boys, *ayas*, and laboratory assistants.

Table 5. Waste disposal system at different hospitals as mentioned by the respondents

Mode of disposal	Director/Head	Doctor/nurse	Cleaners
Sold	14	9	9
Burned	14	10	7
Buried	6	1	2
Dumped	16	6	8
Other *	9	12	11

**collected in an open place, roof of the building, drum or bucket which was taken by van or sweeper to dump in a municipal bin; saline bag re-used for urination, laboratory waste burn with acid, autoclave the waste before disposal, chemical waste thrown in to the basin.*

Table 6. Items disposed off by different disposal system

Sold	Burned	Buried	Dumped	Container/ Basin	Destroyed by acid/ Autoclave
Container	Clothes	Common waste	Disposable	Tips	Cotton
Syringe	Gauze	Needle	syringe	Reagent	Needle
Saline bag	Cotton	Syringe	Saline bag set	Chemicals	Syringe
Disposable	Mattress	Blood lancets	Gloves	Blood	TB slides
syringe	Bandage	Specimen	Needle	Urine	Sputum pot
Bucket	AIDS patient's	collection pot	Cotton	Stool	Vials used for
Saline set	clothes	Blood	Gauze	Sputum	sample
Needle	Rabies patient's	Urine	Bandage	Disposable	collection from
X-ray water	clothe	Stool	Pad	syringe	the patients
Plastic bottle	Paper	Sputum	Paper	Needle	
Ampoules	Gloves	Saline bag	Plastic	Gloves	
Vials	Saline bag	Damaged body	TB slide	Slide	
	Saline set	parts	Sputum	Broken glass	
	X-ray film	Placenta	Polythene		
	Needle	Slides	Blood sample		
	Syringe	cotton	Tissue paper		
	Blood bag		Common		
	Plaster of Paris		wastes		
	Apron		Dressing		
	Disposable		Stool		
	syringe		Urine		
	Plastic		Broken tube		
	Sputum pot		Acid		
	TB slide		bottle		
	Blood		Syringe		

	Urine Stool Bed sheet		Paper packet Placenta		
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There were several modes of waste transport, 44.4% of the respondents mentioned that waste were carried by open bucket and plastic bowl (23.9%). Other modes of transports are listed in Table 7. Medical wastes were disposed off in several places (Table 8). Most wastes were disposed off in municipal bins (59%) without any treatment or separation. This was also the case in Mymensingh and Dinajpur. The diagnostic centre in Mymensingh disposed contagious waste after autoclaving.

Table 7. Mode of Medical waste transportation mentioned by the respondents in Dhaka

Mode of transport	Director/Head	Doctor/nurse	Cleaners	Total answer
Covered bucket	4	1	-	5 (5.68%)
Open bucket	13	14	12	39 (44.38%)
Cart	1	-	1	2 (2.2.7%)
Plastic bag	1	-	1	2 (2.2.7%)
Plastic bowl	5	9	7	21 (23.86%)
Drum	4	2	6	12 (13.64%)
Basket	2	2	2	6 (6.89%)
NS	-	-	1	1 (1.14%)

Table 8. Places of Medical wastes disposed off in Dhaka City mentioned by the respondents

Place of disposal	Director /Head	Doctor/ nurse	Cleaners	Laboratory
Municipal corporation's dustbin	14	10	12	11
Pit near hospital (dig a hole)	5	3	2	3
Open field/road way/ road side	3	2	4	2
Canal water/ river/Lake/ditch				

Own net house/closed house/ own	-	1	-	1
closed dustbin	2	2	1	-

There was no provision for formal training to teach staff how to dispose off Medical waste. Although they received training on laboratory analysis, this was done in an *ad hoc* method. Medical officers were aware that Medical waste could pose a problem. However, most of them thought that they were handling the situation sufficiently. Nurses, laboratory technicians, and *ayas*, had no training on handling and disposal of medical waste.

Of the 82 respondents 32 (38%) mentioned that they did not receive any training on handling Medical waste. Twenty four respondents said that they were told by the authorities about waste disposal. Only seven respondents mentioned that they received training. This was not particular on handling and disposal of medical waste. Few directors, doctors, and laboratory assistants (20) mentioned that they received academic training on nursing or public health only, which was not specifically on Medical waste issues (Annex 4). Similar results were found in Mymensingh and Dinajpur.

Thirty-four (43.59%) respondents mostly directors and divisional heads said that they had not been told by anyone about Medical waste disposal (annex 5). Thirty-six (46.15%) respondents said that they were told by the director or higher authority. Only two directors mentioned that they got the idea from health policy about medical waste disposal. In fact none of the respondent discussed the negative effect of medical waste or the importance of safe disposal of medical waste.

Knowledge

There was insufficient awareness about the issue of medical waste among the respondents at all levels. Out of 107 responses, 88 (82.24%) described Medical waste as general waste (Annex 6) of which 21 were directors or divisional heads, 17 doctors or nurses and the rest were street archins or cleaners, or laboratory assistants. Only one director and four laboratory assistants considered used chemicals as

general waste. Eleven laboratory assistants, one doctor and one director considered laboratory samples of blood, urine, stool, sputum as medical waste etc. One cleaner felt that sometimes body parts could be considered as medical waste. It seems that most people were not aware what to be considered as medical waste. The respondents were also not aware of the harmful or hazardous elements of medical waste. Few respondents (23 of 110) mentioned that pathogens present in medical waste might be hazardous to human health. Only six (5.4%) respondents (either director or doctors) explained the hazardous elements of medical waste (Annex 7). Out of 104 respondents, 21 (20%) did not recognise the impact of medical waste on health (Annex 8). A few respondents said that poisonous chemicals or pathogens can also be transmitted to human body from medical waste. With regard to the environmental impact of medical waste, 35 (37%) respondents (most were street archins and cleaners) said that they did not know of any. Some directors (14) and doctors (8) were also un-aware about environmental impacts of medical waste (Annex 9). Only three heads and 6 doctors explained it well. Divisional heads or directors in Mymensingh and Dinajpur were also not aware about the environmental impact of medical waste. This is likely due to the lack of environmental awareness among the respondents and the majority of people in the country.

Twenty (11 were street archins) out of 94 respondents could explain how plastic or glass waste was recycled (Annex 10). Out of 93 respondents, 69 (74%) did not know or were not aware about the harmful impacts of recycling. Only a director, a doctor and a laboratory technician said that it was not harmful if burnt at 120⁰ C. Fourteen respondents (15%) said that recycling was not harmful but were unable to explain. Only two directors, three doctors, and two laboratory technicians could explain the harmful impacts of recycling as burning of plastic, toxic chemical or pathogen containing materials may have harmful impact if it is recycled.

Observations

Most clinics and laboratories had no waste management system in place. Municipal bins and dumping grounds were often used for disposal. They were found less concerned about proper disposal of Medical waste. BIRDEM Hospital, Infectious Diseases Hospital in Dhaka, and Dancun's Diagnostic Centre in

Mymensingh autoclaved waste and used less harmful chemicals for fixing of slides. However, they still placed all their wastes in municipal bins like other clinics and laboratories. Some other private clinics and laboratories had a terrible edict in handling their samples and wastes. The management of most of these hospitals and clinics do not concern themselves with disposal, and believe that placing waste in municipal bins or down the drain is enough.

Some clinics and laboratories used to clean used syringes and instruments by disinfectant such as dettol and detergents. These agents are less harmful than phenol, which most hospitals used for disinfection. In all laboratories and clinics, liquid waste was disposed off in drain, latrine or municipal garbage bin. Autoclave was used in most cases for sterilization, and this avoids the use of phenol.

The real situation of the government hospitals and clinics visited were unbelievable. Unsanitary pathological analysis, cleaning, and testing were evident in the laboratory. Laboratories re-used syringes and it seemed that they re-used needles as well. Some mentioned that they re-used gloves, musk, slides, test tubes etc.

Laboratory analysis

Type of tests conducted in laboratories of different hospitals and diagnostic centres were blood test or serology, urine, stool, sputum, X-ray, ultra-sonogram, endoscopy, radio therapy, microbial test /infectious disease (e.g. diarrhoea, dysentery, TB), kidney function, diabetic, ECG, AIDS, cancer (Biopsy), skin test (Leprosy AFB), and CT scan. Almost all laboratories performed blood, stool and urine tests. There were only three hospitals which specifically dealt with infectious diseases (Infectious Diseases Hospital Dhaka and TB clinic Dinajpur). There were few hospitals also testing for AIDS, cancer, and leprosy.

Exposure to infectious diseases

There were several incidents (10 out of 17 cases) of injury due to the exposure of Medical waste inside or outside of hospital premises. These were as follows:

- Hands cut due to handling of broken glasses
- Fingers permanently damaged/became curved due to injury by needle,
- Right hands became paralyzed by injury from a needle,

- Two legs became paralyzed due to injury from a needle,
- Skin diseases on legs and hands,
- Puss due to injury, and
- Ulcer on legs.

Laboratory analysis of hospital waste

Few selected pathogens were tested from collected hospital waste. These were Salmonella, Shigella, Mycobacteria, and Amoeba (Table 9). Samples were collected from several sources including dustbins (where hospital wastes were dumped), wastewater from hospital drains, and laboratory basins from different hospitals. Names of sampling sites are given in annex 14. Laboratory analysis showed improper disposal of Hospital waste and severe contamination of these infectious wastes to the environment. Laboratory analysis shows high levels of contamination from infectious wastes at various sources in the environment (Table 9). Children, adults, and animals all have the potential to come into contact with these wastes that may pose severe health risks to them.

Table 9. Pathogens (number per gm in solid sample and per 100ml in liquid) in hospital waste analyzed from different sources

Source of waste sample	Salmonella/ 100ml or gm	Shigella/ 100ml or gm	Mycobacteria/ 100ml or gm	Amoeba/ 100ml or gm
Dustbin	2.5x10	6.4x10	2.3x10	3.8x10
Basin water	2.7x10	1.1x10	1.1x10	3
Dustbin	3.2x10	3.6x10	4.7x10	5.3x10
Basin water	3.2x10	1.7x10	15	<1
Basin water	1.6x10	35x10	5	<1
Dustbin	2.3x10	7.7x10	1.8x10	6.2x10
Basin water	1.8x10	0.5x10	2.9x10	1.3x10
Dustbin	1.2x10	2.0x10	3.5x10	7.4x10
Dustbin	1.1x10	1.0x10	2.5x10	5.0x10

Basin water	4.0x10	1.0x10	18	<1
Soil	3.1x10	7.2x10	3.4x10	2.7x10
Water	6.8x10	1.2x10	7	5
solid	2.5x10	2.0x10	5.6x10	3.9x10
water	2.9x10	3.1x10	3	1.2x10

HEALTH AND ENVIRONMENTAL ASSESSMENT

Medical wastes are a source of contamination and pollution to both humans and the natural environment as discussed in this paper. Improper disposal may be hazardous if it leads to contamination of water supplies or local sources used by nearby communities or wildlife. Sometimes exposed waste may become accessible to scavengers and children if a landfill is insecure. Medical wastes are potentially capable of causing disease and illness in man, either through direct contact or indirectly by contamination of soil, groundwater, surface water and air. Wind blown dusts from these dumps also have the potential to carry pathogens and hazardous materials. Where domestic animals are allowed to graze in open dumps, there is a risk of reintroducing pathogenic micro-organisms into the food chain. Medical wastes therefore pose a risk to individuals, communities, and the environment if not carefully handled.

The pathological laboratories of medical center examine blood, stool, urine, and sputum. The chemicals used for staining and preservation of slides and for the sterilization and cleaning of equipment and surroundings are potentially harmful to laboratory technicians and the environment. Most of the chemicals are poured down the sink and drain out next to the clinic. Children, adults, and animals all have the potential to come into contact with these chemicals. Xylene, phenol, methylene blue, hydrochloric acid, chlorine and carbol fuchsin are all used, and some can have very damaging effects (2). Other than these, a large number of chemicals also used in different diagnosis and treatment (e.g. chemotherapy).

Improper medical waste disposal may have the following environmental and health impacts.

A. The main health risks of Medical wastes are summarized below (modified from WHO, 1999) (10).

- Contamination of drinking water. Possibility of leachate entering an aquifer, surface water or drinking water system.
- Non-biodegradable antibiotics, antineoplastics and disinfectants disposed of into the sewage system may kill bacteria necessary for treatment of sewage. Antineoplastics flushed into watercourses may damage aquatic life or contaminate drinking water.
- Burning of waste at low temperatures or in open container results in release of toxic pollutants (e.g. dioxin) in the air.
- Carcinogenic waste such as heavy metals, chemical solvents and preservatives pose serious human health risks not only to workers but to the general public as well.
- Inefficient and insecure sorting and disposal may allow drugs beyond their expiry date.
- Unprotected and insecure landfill may pose health hazard to the scavengers and inhabitants at the vicinity.

B. Environmental hazards related to Medical waste

The following are environmental impacts associated with improper disposal of Medical wastes:

- Pollutants from Medical waste (e.g. heavy metals and PCBs) are persistent in the environment.
- Accumulation of toxic chemicals within soil (proximity to agricultural fields, humans, soil organisms, wildlife, cattle).
- Groundwater contamination, decrease in water quality.
- Bio-accumulation in organism's fat tissues, and biomagnify through the food chain.
- Repeated and indiscriminate application of chemicals over a long period of time has serious adverse effects on soil microbial population - reducing the rate of decomposition, and generally lowering the soil fertility.

- Pathogens lead to long-term accumulation of toxic substances in the soil.
- Specimens collected for analysis have the potential to cause disease and illness in man, either through direct contact or indirectly by contamination of soil, groundwater, surface water, and air
- Wind blown dusts from indiscriminately dumping also have the potential to carry hazardous particulate.
- With domestic animals being allowed to graze in open dumps, there is added risk of reintroducing pathogenic micro-organisms into the food chain.
- Public nuisance (e.g. odors, scenic view, block the walkway, aesthetics, etc.).
- Improper sterilization of instruments used in labour room may cause infection to mother and child.
- Combination of both degradable and non-degradable waste increase the rate of habitat destruction due to the increasing number of sites necessary for disposal of wastes (degradation of habitat).
- Plastic bags, plastic containers, if not properly destroyed may contaminate the soil and also reduces the chance for water percolation into the soil during precipitation.
- Open air burning does not guarantee proper incineration, and releases toxic fumes (dioxin) into the atmosphere from the burning of plastics i.e., PCB's.

CONCLUSION

From this investigation it is found that the contagious disease section of pathological laboratories produce hazardous and pathological waste. Wastes from hospital such as placenta, syringes, needles, sputum pots, chemical agents are all potential areas of concern for hospital waste management.

In most cases wastes were thrown into municipal bins, without regard to the harmful effects they may pose to human health and the environment. Proper laboratory techniques (both preparation and analysis), and disposal were completely disregarded. Various methods were used by the clinics to dispose off waste such as burning, burial, and entombing. None of the clinics re-used syringes and other things and sold their waste. In contrast, government hospitals re-used syringes and sold medical waste.

According to the US Army Centre for Health and Preventive Medicine (1995), Medical waste must be segregated from regular waste starting at the point of generation and continuing during storage, in transportation and through to point of treatment. Unfortunately, there is no structured form of medical wastes treatment in Bangladesh, and most wastes are dumped in open areas for natural degradation or re-sold by scavengers (2). A significant number of urban poor in Bangladesh depend on collection of secondary materials for their livelihoods. The scavengers sort out waste at dumping site, usually open dumps and sell anything that can be recycled. The waste pickers do not take any special precaution for sorting out waste and thus are vulnerable to infection, serious injury or sickness.

There was no safety measure observed in dealing with waste disposal or laboratory analysis of infectious or hazardous samples. The chemicals used for staining and preservation of “slides” and for sterilization and cleaning of equipment and “surroundings” are potentially harmful to laboratory technicians and the environment. This is due to lack of environmental awareness among the respondents.

The findings indicate that there is a need to improve Medical waste handling and disposal methods. In most government hospitals, private laboratories and clinics waste is disposed in municipal bins without considering the harmful effects they may pose to human health and the environment. There is no waste

disposal system in place to manage Medical waste. Most hospital officials visited believed that they were disposing their waste in an appropriate manner. Though some medical officers did show their concern and generally wanted to improve the situation, most health care workers had only a basic understanding of health care and did not perceive that improper handling or disposal of medial waste could be a hazard.

Some methods are suggessted on safe handling and disposal of most serious chemicals and pathological waste.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made to improve the medical waste management in Bangladesh:

1. Raise awareness and education on medical waste issues,
2. Proper waste management strategy is needed to ensure health and environmental safety from medical waste,
3. Segregation of medical waste should be done at the point of generation. Different coloured bags should be used for collection of hazardous and non-hazardous waste,
4. Safety protection must be taken in handling hazardous waste. Gloves, masks, aprons, etc. must be used during handling of medical waste,
5. Hazardous medical waste may be collected from different hospitals and treated centrally. Methods of treatment should be selected carefully,
6. To minimize the generation of medical waste, good housekeeping, replacement of chemicals, etc. may be adopted,
7. Training programme on safe handling of medical waste can be organised for medical staff,
8. Government should promulgate and implement laws and regulations regarding medical waste management.

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Annex 1. List of hospitals studied

Type 1: Govt. or public hospitals

1. Dhaka Medical College Hospital, Dhaka
2. Infectious disease hospital (T.B. hospital), Dhaka
3. Ibrahim Memorial Diabetic Hospital (BIRDEM), Dhaka
4. Sohrawardi Hospital, Dhaka
5. Shishu Hospital, Dhaka
6. Leprosy Hospital, Dhaka
7. Infectious Disease Hospital, Dhaka
8. Cancer Institute and Hospital, Dhaka
9. Orthopedic Hospital, Dhaka
10. TB Clinic, Dinajpur
11. Dinajpur Medical College and Hospital, Dinajpur
12. Parbotipur Thana Health and Family Planning Centre, Dinajpur
13. Mymensingh Medical College and Hospital, Mymensingh
14. Rupshi Government Health and Family Planning Centre, Mymensingh

Type 2: Private hospitals

1. Holy Family Red Crescent Hospital, Dhaka
2. ODSB Maternity Hospital, Dhaka
3. Delta Medical Centre and Clinic, Dhaka
4. Dhaka ENT Hospital Clinic, Dhaka
5. Aroggaya Nikaton Hospital, Dhaka
6. Ayasha Memorial Hospital, Dhaka
7. Medichcek Clinic, Dhaka
8. Aivhy Maternal and Shishu Hospital, Dhaka
9. Rashmono clinic, Dhaka
10. Rogmukti Clinic, Dinajpur

11. Seven Day Clinic, Dinajpur

Type 3: Diagnostic centers

1. Lion Dental & Physiotherapy centre, Dhaka
2. Reliance Diagnostic Centre, Dhaka
3. Green X-ray & Green Laboratory, Dhaka
4. Dhaka laboratory, Dhaka
5. Popular Diagnostic Center, Dhaka
6. Executive Health Check Center, Dhaka
7. IbneSina laboratory, Dhaka
8. City Diagnostic Clinic, Dhaka
9. Prophecy Diagnostic Centre, Dhaka.
10. General Diagnostic Centre, Dhaka
11. National Diagnostic Centre, Dhaka
12. Dankan's Diagnostic Centre, Mymensingh
13. Doctor's Pathology, Dinajpur

Annex 2. List of hospitals from where samples were taken for laboratory analysis of solid waste and wastewater.

1. Sohrawardi Hospital, Dhaka
2. Dhaka Medical College and Hospital, Dhaka
3. Infectious Diseases Hospital, Dhaka
4. Delta Medical Centre and Clinic, Dhaka
5. Dhaka ENT Hospital Clinic, Rd. 4/A, H 56, Dhanmondi
6. Popular diagnostic Center, 272/ Elephant rd.

Annex 3. Number of patients in a day (Dhaka only)

No. of beds	No. of hospitals	No. of outdoor patients/day	No. of hospitals
10-30	6-7	1-5	1 -3
50,55	2	15-50	3-7
100	1	70-150	3-4
300 & 305	2	160-400	2-3
400 & 546	2-3	900	1
600	1	1000	1
800	1	4000	1
Not stated	7	Not stated	3-4

Annex 4. Training or special precautions on how to handle Hospital wastes mentioned by the respondents

Respond of training	Director /Head	Doctor / nurse	Cleaners	Laboratory Assistant.	Total answers
No training received	11	4	10	7	32 (38.1%)
Told by authority	8	4	9	3	24 (28.57%)
Training (little/small)/ special training (e.g. infection)	2	3	-	-	5 (5.95%)
Training (Formal) e.g. UNICEF, Gono Shasthya)	2	-	-	-	2 (2.38%)
Academic training (nursing, public health)	2	10	1	7	20 (23,81%)
Reading book, journal, news paper	-	1	-	-	1 (1.19%)

Annex 5. Sources of voice about disposal of medical wastes

Respond of concerns	Director /Head	Doctor /nurse	Cleaners	Laboratory Assistant	Total answers
No	15	7	6	6	34 (43.59%)
Yes, authority/Doctor/Director/ nurse, senior nurse	4	10	11	11	36 (46.15%)
Somebody outside institute (NGO worker, researcher)	-	-	-	-	-
Mass media (Radio, TV)	1	-	2	-	3 (3.85%)
Educational institute	1	2	-	-	3 (3.85%)
Get idea from health policy	2	-	-	-	2 (2.56)

Annex 6 General composition of hospital waste mentioned by the respondents

Composition of Hospital waste	Director /Head	Doctor/ nurse	Street Archins	Cleaners	Laboratory Assistant	Total answer
Normal waste (gauge, bandage, saline bag, plastic, syringe, needle, food waste)	21	17	17	18	15	88
Including above+ chemical/ acids	1	-	-	-	4	5
Including no.1+ tested sample (blood, urine, stool, sputum etc.)	1	1	-	-	11	-
No. 1, 2, and 3 together	-	-	-	-	-	-
All mentioned above or No. 1 + body part of the patients	-	-	-	1	-	1

Annex 7 Knowledge on hazardous or harmful elements

Knowledge on toxic, hazardous or harmful elements	Dorector /Head	Doctor /Nurse	Street Archins	Cleaners	Laboratory Assistant	Total answers
Don't know	1	-	5	3	2	11

Nothing special to mention	6	4	2	3	2	17
Infectious/complex disease/pathogen/ blood/pus	4	6	1	1	3	15
Pathogen (malaria, diarrhoea, dysentery, HB+)	8	4	2	5	4	23
Toxic chemical/ injection	-	2	5	4	6	17
Syringe/ blade/ broken bottle	2	2	2	1	1	8
Detailed explanation with toxic or hazardous things	5	-	1	-	-	6
Yes, toxic things may be present but no explanation	3	4	2	3	1	13

Annex 8 Experience on how hospital waste affect human health

Knowledge about affect on human health	Director /Head	Doctor/ nurse	Street archins	Cleaners	Laboratory Assistant	Total answers
Don't know/ do not do	4	3	5	6	3	21 (20.19%)
Does affect but no explanation	8	6	6	3	6	29 (27.88%)
Waste mixed with hazardous chemical or pathogen	3	3	1	-	4	11 (10.58%)
Syringe needle contaminated with hazardous chemical or pathogen	4	4	3	2	1	14 (13.46%)
Plastic bag or plastic waste/saline bag	-	1	1	-	-	2 (1.92%)
Have not seen to affect any one	5	6	1	5	2	19 (18.27%)
Pathogen (Dysentery, stomach ache, diarrhoea etc.)	2	-	-	4	2	8 (7.69%)

Annex 9 Knowledge on Environmental Impacts

Knowledge about affect on environment	Director /Head	Doctor/ nurse	Street Archins	Cleaners	Laboratory Assistant	Total answer
Don't know/ does not do	1	4	14	12	4	35 (37.23%)
Does, all kind of waste	14	8	3	1	5	31 (32.98%)
Plastic, saline bag, syringe	-	-	-	-	-	
Hazardous/Infectious disease, chemical or pathogen	3	1	-	2	4	10 (10.64%)
Hazardous chemical	-	-	-	-	1	1 (1.06%)
Detail description, how it affects water, soil, and air around	3	6	-	2	3	14 (14.89%)
No specific explanation	1	-	-	2	-	3 (3.19%)

Annex 10 Knowledge on recycling

Knowledge about recycling	Director /Head	Doctor/ nurse	Street Archins	Cleaners	Laboratory Assistant	Total answer
Don't know	5	4	5	12	9	35 (36.08%)
Know little/heard	12	6	1	3	5	27 (27.84%)
Saline bag/different things made of plastic e.g. Comb, ball-pen, bag etc.	4	2	2	1	1	10 (10.31%)
Sofa made of fruit skin (Coconut)						
Selling plastic or glass collected to others	1	-	-	-	-	1 (1.03%)
	-	1	9	-	-	10 (10.31%)
No recycling/ don't recycling	4	5	-	3	2	14 (14.43%)