

HOSPITAL WASTE MANAGEMENT: BANGLADESH

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Abstract: Hospital waste is infectious and hazardous which poses serious threats to environmental health and requires specific treatment and management prior to its final disposal. Appropriate and safe management of healthcare waste is acknowledged globally. WHO and Environmental Protection Agency (EPA) have emphasised the need to handle and dispose of hospital waste from the healthcare establishments in proper ways. City Corporations are responsible for solid waste management in the country. However the collection of the waste is often irregular, leading to unsanitary conditions near the primary collection points. Many towns do not have the capacity to collect all the waste, and often proper sanitary disposal is problematic. In Bangladesh hospital waste management is growing with an ever-increasing number of hospitals, clinics, and diagnostic laboratories especially in Dhaka City. Thus healthcare waste management is neglected and it falls under the auspices of the local municipal bodies which are responsible for the collection, removal and disposal of different kinds of wastes from public places. This paper aims to discover and understand the current situation of healthcare waste management that includes waste handling, collection and disposal as well as the knowledge and awareness level of individuals involved in healthcare. Furthermore, the paper also explores alternative options for the management of hospital wastes that is environmentally friendly. Research on this critical issue has been very limited, and there is a serious shortage of information which is essential for strategic for planning.

Keywords: collection, disposal, hospital waste, management, segregation, treatment

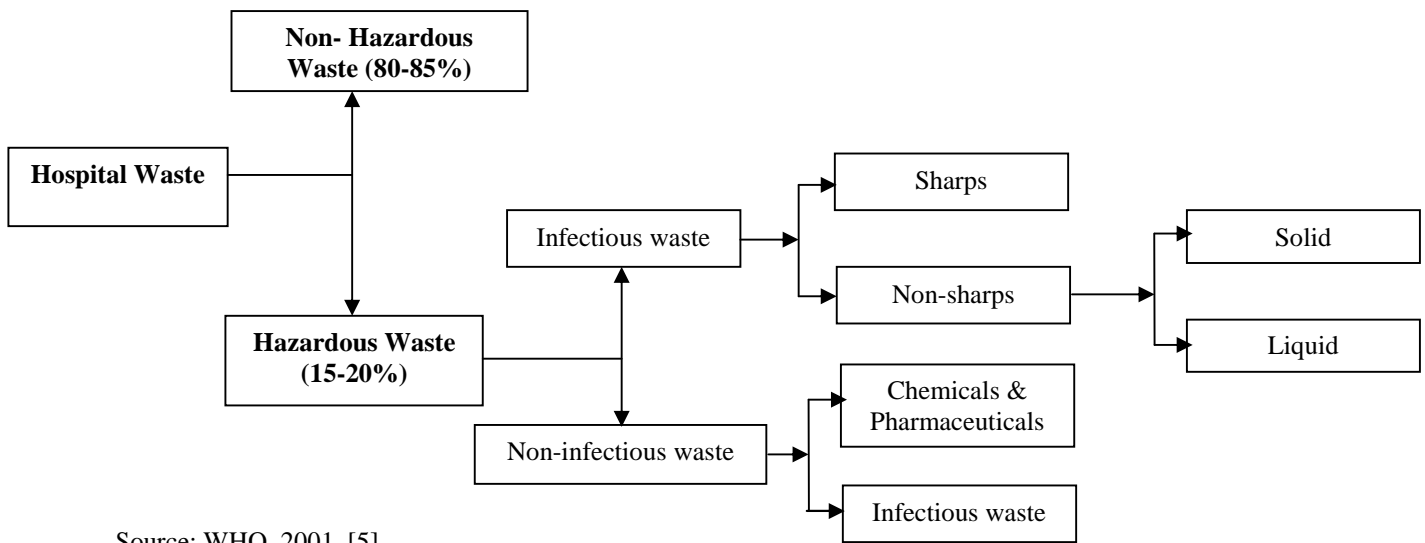
INTRODUCTION

The main purpose of any health care institution is to provide health services to people who are suffering from various kinds of illnesses. Hence it is important to keep health centres clean and environmentally sound. Ironically, most of the health care centres especially those that are run by the government in Bangladesh are in poor condition unclean and polluting the environment with high toxic substances. In Bangladesh these hospitals/clinics are causing serious environmental problems for communities and the people who work in these places. Therefore management of hazardous hospital waste is a growing concern in Bangladesh. The country has some 460 Upzilla level Hospitals and 9722

community level clinics and about 1449 outdoor health facilities at Union level that falls under DGHS [1]. From the same study it was also found that at district level there are about 117 hospitals that are currently functioning [1]. Among the private hospitals there are about 2501 registered hospitals and 5122 registered diagnostic centres throughout the country [1]. In addition there are many clinics, including about 5000 government and NGO run clinics, and doctor's chambers where health care waste is generated. In Dhaka City alone there are about 1200 hospitals, clinics and diagnostic centres [2]. According to Dhaka City Corporation (DCC) research report, waste generated per person per day is about 0.5kg. In the same report it was identified that 3700 metric tons of wastes are generated per day in Dhaka City, of which about 200 tons are hospital waste and 40 tons are infectious waste [3]. The amount is increasing every day, with rising number of medical establishments where wastes are not managed properly. The fact that knowledge on the means of segregating hazardous and non-hazardous waste is low, it is difficult to secure proper information upgrading the actual amount of waste that is generated every day. In different countries World Health Organisation (WHO) and Environmental Protection Agency's (EPA) have emphasized the need to handle and dispose medical wastes in properly. In Bangladesh hospital waste management which falls under the auspices of the municipal bodies is being neglected. The Municipal authorities are responsible for the collection, removal and disposal of different kinds of medical wastes from public places to the dumping grounds; naturally standing they are not efficiently handling the matter. Until recently, the management of medical wastes received little attention despite their potential environmental hazards and public health risks. The paper attempts to identify the waste management practice in the country along with the reasons for waste management failure.

MEDICAL WASTE

The wastes that are being generated from hospitals, clinics or institutions that provide healthcare services are commonly known as hospital waste or medical waste. The hospitals produce a wide variety of medical wastes ranging from general waste (like food waste, paper waste) to hazardous biological, chemical and radiological wastes [4]. In a broad term medical wastes can be of two types shown in the following figure 1:



Source: WHO, 2001, [5]

Figure 1: Different Types Hospital Wastes

Table 1: Different Categories of Hospital Wastes with Examples

| WASTE CATEGORY | Description with Examples |
|---|--|
| Infectious waste | Pathogens may be present. E.g. excreta, laboratory cultures, tissues, materials or equipment that have been in contact with infected patient. |
| Pathological waste | Human tissues or fluids. E.g. blood and other body fluids, foetuses. |
| Pharmaceutical waste | Wastes containing pharmaceuticals. E.g. pharmaceuticals that are no longer needed or expired |
| Genotoxic waste | Waste containing substances with genotoxic properties. e.g. waste containing cytotoxic drugs (often used in cancer therapy); genotoxic chemicals. |
| Chemical waste | Chemical substances present in a waste. E.g. laboratory reagents, film developer; disinfectants that are expired or no longer needed; solvent. |
| Wastes with high content of heavy metals | Batteries, broken thermometers, blood-pressure gauges. |
| Pressurized containers | Gas cylinders, aerosol cans |
| Radioactive waste | Radioactive substances present in a waste. e.g. unused liquids from radiotherapy or laboratory research, contaminate glassware, packages or absorbent paper. |
| Sharps | Sharp wastes. E.g. needles, knives, blades, broken glass infusion sets. |

The composition of medical wastes varies from country to country even within a country as it depends on the type of health services they are providing to the people. The following table 1 [6] shows the wastes that are commonly found in all the hospitals all over the world.

Sources of Medical Waste: The sources of medical waste can be grouped as major and minor according to

the quantities produced. The minor sources are scattered that produces similar kinds of waste as major sources but these waste does not contain radioactive wastes, no human body parts and among the sharps they consist mainly of hypodermic needles [7]. An attempt has been made to demonstrate the sources below in figure 2:

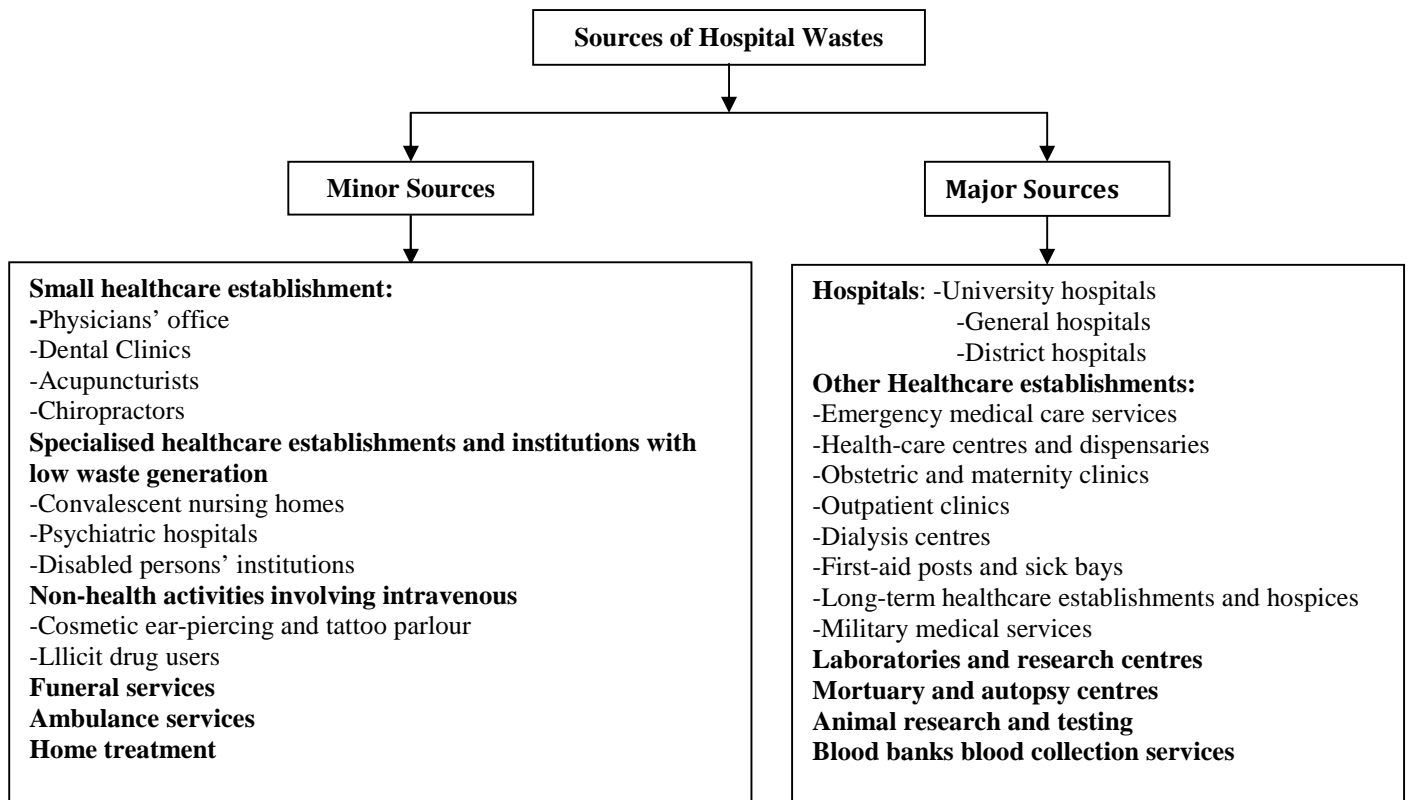


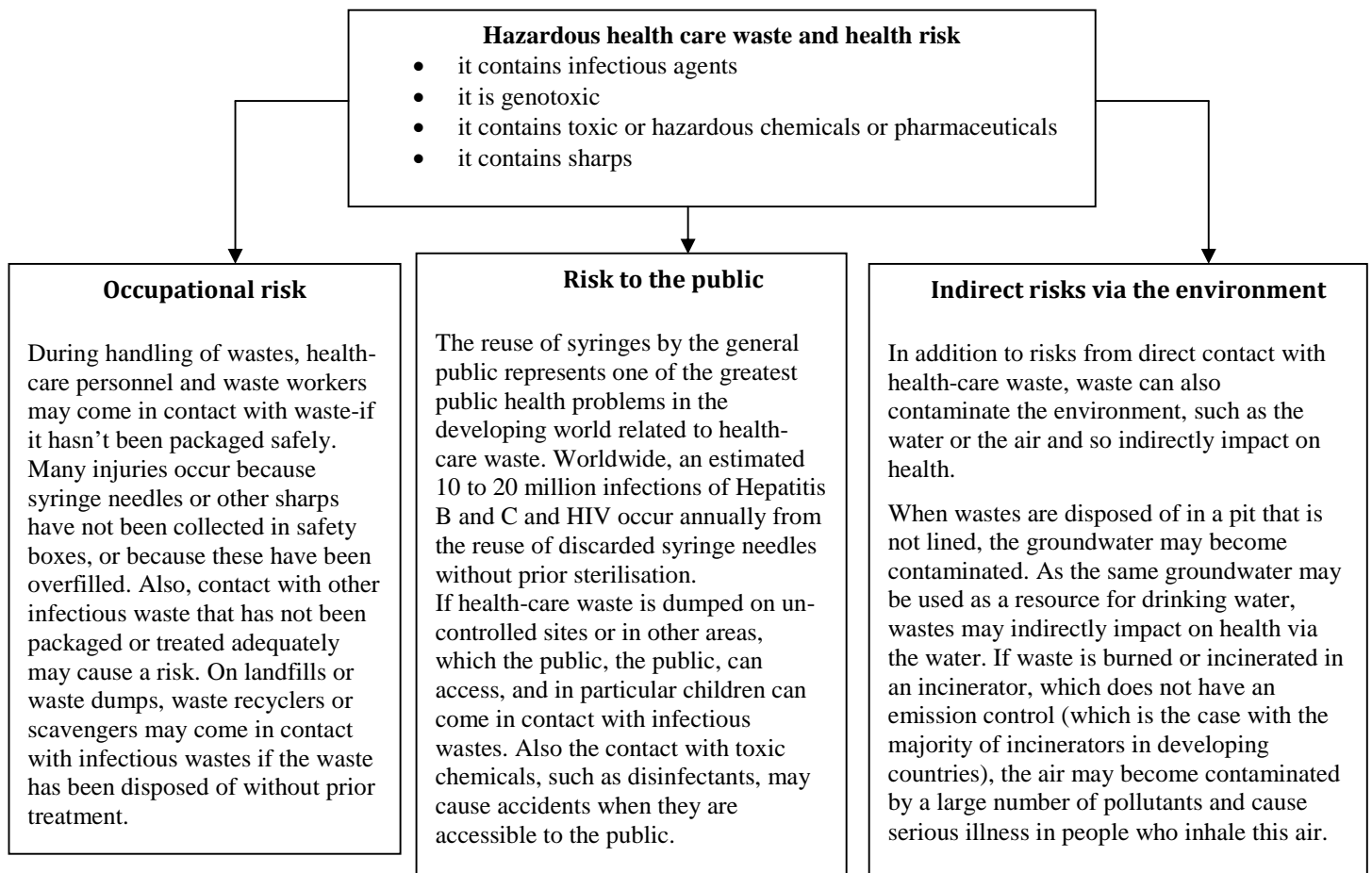
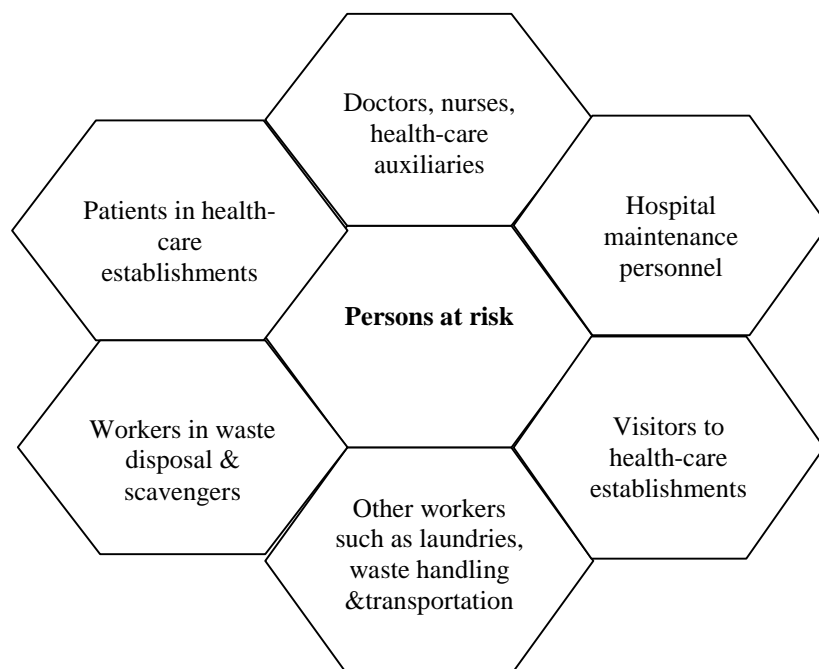
Figure 2: Sources of Medical Wastes

Effects of Medical Waste

The poor management of medical wastes is an obvious risk to people and the environment as they contains infectious agents, genotoxic materials, toxic or hazardous chemicals or pharmaceuticals and sharps microorganisms, which enter the human body via a number of ways and cause diseases. These risks have so far been poorly investigated. Waste and by-products can also cause injuries, for example radiation burns or sharp-inflicted injuries; poisoning and pollution, whether through the release of pharmaceutical products, in particular, antibiotics and cytotoxic drugs, through the waste water or by toxic elements or compounds such as mercury or dioxins [8]. The common diseases connected are: (a) Gastroenteric infectious (b)

Respiratory infectious (c) Urinary tract infection (d) Skin infection (e) Meningitis (f) Viral Hepatitis A, B and C (g) Tetanus

There are numerous other diseases, which could be transmitted by contact with health-care wastes. The hazardous nature of hospital waste may be due to one or more of the characteristics that cause health risk in different ways shown in figure 3 [9]. There are many people who are at risk directly and indirectly as they come in to contact with the medical waste while handling the waste. The public may also come in to contact as they are thrown in to open places or carried environment by air and water. In this process of medical waste management the people who are at risk are shown in figure 4 [10].

Figure 3: Different Kinds of Risk Associated with Hazardous Health-care Waste**Figure 4: Persons at Risk**

The people are exposed to the diseases of patients, as the public hospitals do not provide them with proper equipment and facility. The nurses, sweepers and cleaners are not aware of precautionary measures while disposing of the hazardous hospital/clinical waste. The scavengers outside the hospitals are exposed to the hospital/clinical waste, as the waste is disposed into the City Corporation dustbin. Studies have not been carried out on the health effects of the community or on those who are exposed to the hospital/clinical waste in Bangladesh. According to Akter [11] there were reports of different injuries of injury due to exposure to medical wastes inside or outside of hospital premises such as, hands cut, skin diseases, ulcers and injuries by needle.

MEDICAL WASTE MANAGEMENT

Broadly waste management means, managing the waste from the place it is generated till the ultimate disposal. According to Rushbrook, [12] defines hospital waste management as below: *Good management of health care waste in hospitals means the effective segregation of waste and the separate handling and disposal of each segregated waste category. This cannot be achieved without the commitment of senior directors and the motivation of medical and support staff.*

The main goal of bio-medical waste management is to protect the public health; promote the quality and sustainability of environment and to support the economic productivity. Health-care waste management is now an important agenda throughout the world both in developed and developing countries. To achieve appropriate health-care waste management, which is environmentally friendly as well economically viable for every country especially for the developing countries is now the primary concern. According to WHO [7] any formulation of objectives and planning for their achievement are important for improving health-care waste management at the national, regional, and local level. Agenda 21 recommends a set of measures for proper waste management that is summarised as below [6]: (a) Prevent and minimise waste production (b) Reuse or recycle the waste to the extent possible (c) Treat waste by the final residues by landfill in confined and carefully designed sites.

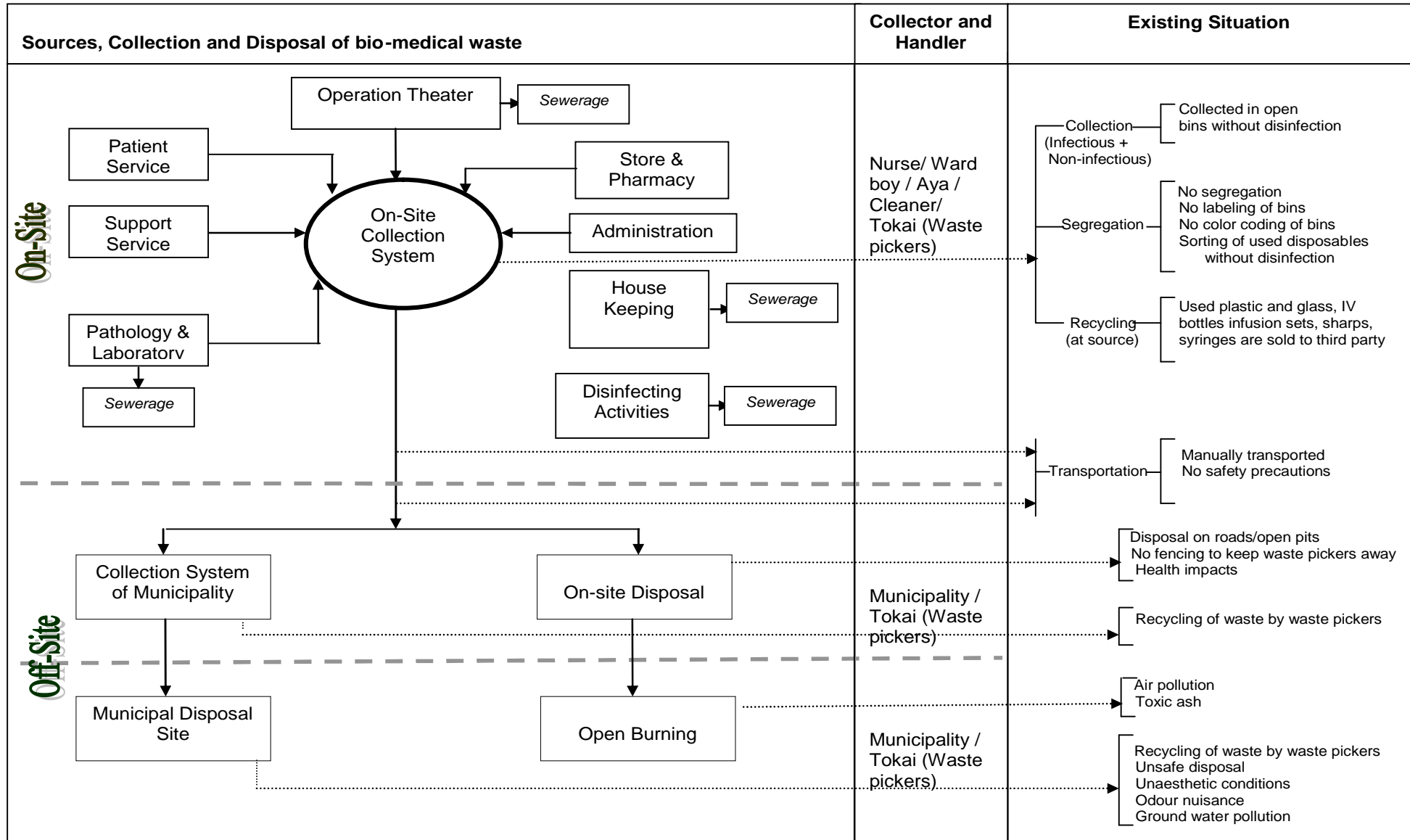
Therefore proper management of hospital waste requires achieving the goal of minimizing health hazards and making the hospital environment friendly. World Health Organisation [8] provides guideline for all hospitals to comply with in order to ensure safe medical waste management. These are (a) **Waste Minimisation at source** by reuse, recover and stock management; (b) **Waste Segregation** by categories and sharps; (c) **Waste Identification** by colour coding for different wastes; (d) **Waste Collection and storage** by routine programme; (e) **Waste Transfer** by following "chalked Path way from generation to disposal sites and use enclosed vehicle (f) **Treatment Option** by both burn and non-burn ways:

The countries in the north have already adopted new

technologies and new management systems for their health-care waste management. At present these nations are addressing the waste issues in more environmental friendly manner. The monitor and evaluate their systems everyday with new technologies and developing new policies. In Bangladesh, proper medical waste management is a new phenomenon and the government is trying to develop a new and modern approach to deal with the medical waste properly. There is no national policy on medical waste management in Bangladesh. For a proper and scientific management of medical waste, the government should give priority to formulating a policy. Moreover, the existing laws are outdated and impose by low penalties and sometimes, no penalties for offenders. Thus, massive awareness on this issue and new tougher laws could be effective in protecting people and the environment from deadly medical waste. Recently a law has been proposed to handle medical waste properly, but it needs to be adopted and enforced as soon as possible. The department of Environment has developed a Hospital Waste Pocket Book in 2004 which was revised in June 2010 [13]. This book is supported by Medical Waste Management Rules 2008 [14]. The Pocket book includes all the standard procedures for proper management system for all health care establishments. The book clearly indicates types of hospital waste along with the colour codes for waste segregation. Responsibilities of individuals who handle the wastes in the hospitals are explicitly described. It also includes ways in which the waste should be transported and stored the hospital premises. This guide represents best practice and ensures, at minimum, compliance with current regulations. However it does not include an appropriate, safe, and cost-effective strategy and only concerns itself with treatment, recycling, transport, and disposal options.

In Bangladesh the healthcare centres like hospitals, clinics, nursing homes, dental hospitals etc have inadequate waste management systems which is a threat to public health as well as to the environment [15]. Neither the government nor hospital authorities pay proper attention to this matter. Almost every hospital/clinic is disposing both non-hazardous and hazardous wastes in the nearby municipality dustbins or roadside without any sort of treatment. As a result an unhealthy and hazardous environment exists in and around the hospitals that are affecting the patients, hospital staffs and other people who are exposed to these conditions. A study in 2005 [16] reveals that improper procedures of medical waste management exist in the country. It also found that some of the hospitals separate infectious wastes from the non-infectious waste stream at the site of production, but during disposal it is done in municipality dustbins where the wastes were mixed together [16]. The following figure 5 shows commonly practiced hospital waste management system in Bangladesh [17].

Figure 5: Practiced Hospital Waste Management System in Bangladesh



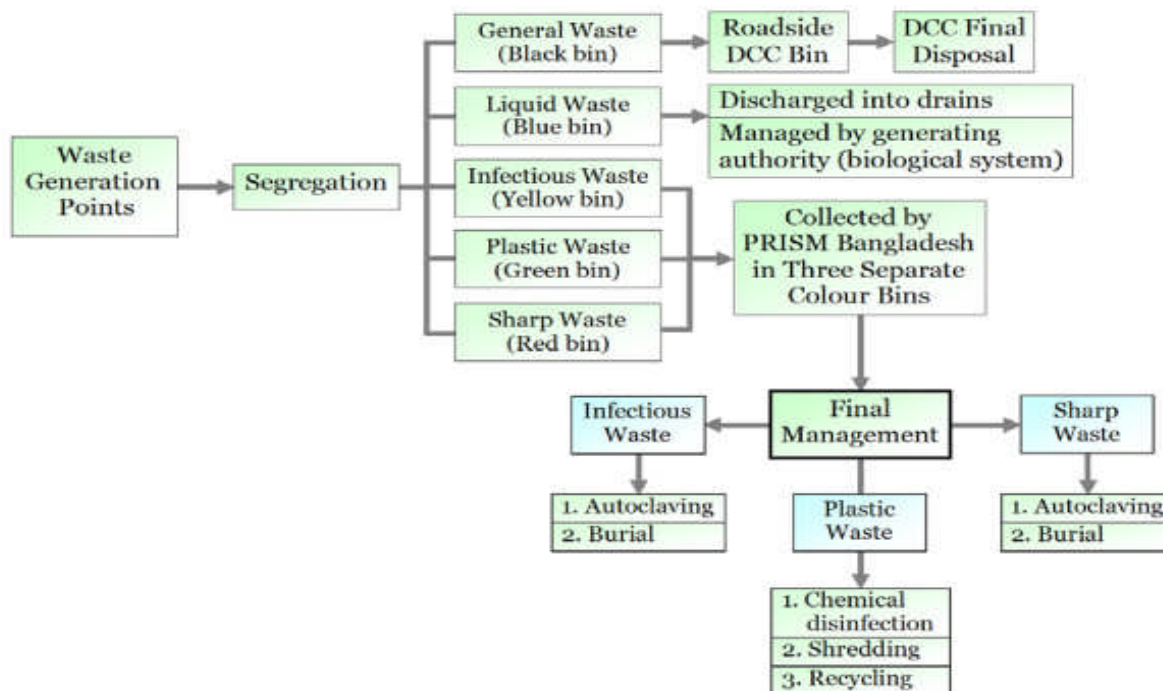


Figure 6: Hospital Waste Management System by PRISM Bangladesh

There are only three NGOs in Bangladesh that are actively working in the field of hospital waste management. These NGOs are PRISM (Project in Agriculture, Rural Industry, Science and Medicine) Bangladesh in Dhaka city, BASA in Tongi and Shawpno in Bagura. They are collecting the waste from the hospitals with a nominal service charge. Among the three NGOs, PRISM Bangladesh along with DCC is properly collecting and treating the hospital waste up to final disposal. There are only 342 hospitals, clinics and diagnostic centres under PRISM Hospital waste management programme (In conversation with PRISM). Rest of the healthcare institutions follow their own or old system. The following figure 6 shows existing waste management practice in some health care establishments organised by PRISM Bangladesh [16]:

Majority of the hospitals, clinics and diagnostic centres in the country do not have any waste management treatment plant nor do they give proper attention to the problem of hospital waste management. Till today, all the hospitals discharge their liquid pharmaceutical and chemical waste into the general sewers or drains because none of them have any proper liquid waste management system. Liquid waste is mainly generated from patients' service units, operation and surgical units, laboratories and other health-care units. As a result, the water bodies in Bangladesh are being polluted by the liquid wastes.

WASTE MANAGEMENT FAILURE

Hospital waste management in Bangladesh needs to be stressed as it is causing serious damage to both our health and environment. Despite having a hospital waste management pocket book since 2008, the government has not been successful to ensure the implementation of

the guideline in both public and private hospitals/clinics. Out of reasons for not being able to implement it successfully is that authorities and owner of hospitals/clinics are not aware of the effects on the environment and people. They also lack interest and all not bothered to improve or update their disposal methods as there is a cost involved. Thus there are only few people who are aware of the issue but they are outnumbered for which they cannot take any steps to improve the situation. Moreover the staffs who are handling wastes are illiterate and results have little knowledge about the impact. In private hospitals/clinics the nurses dispose of wastes according to the management instruction of the hospital. As a result the staffs are not aware and responsible for executing the proper way in which of hospital waste should be discarded. Institutions that are aware are don't have proper management system and guidelines. On the other hand the actual problems observed in both public and private hospitals/clinics and diagnostic centres are: (a) No alternative methods for safe disposal (b) No system for segregating the waste before disposal (c) No specific regular awareness programme among all staff (d) No protection for waste handlers, which are often infectious and potentially dangerous (e) No specific training program for the nurses and cleaners regarding waste handling, disposal or management.

The hospital waste management practices somehow have not been given appropriate attention and importance in Bangladesh for which it has not been successful in achieving better medical waste management. Other problems include: (a) Lack of implementation of guideline (b) Existing gaps within the waste management rule 2008 (c) Problem in Environmental Act 1995 (d) Lack of interest and unity

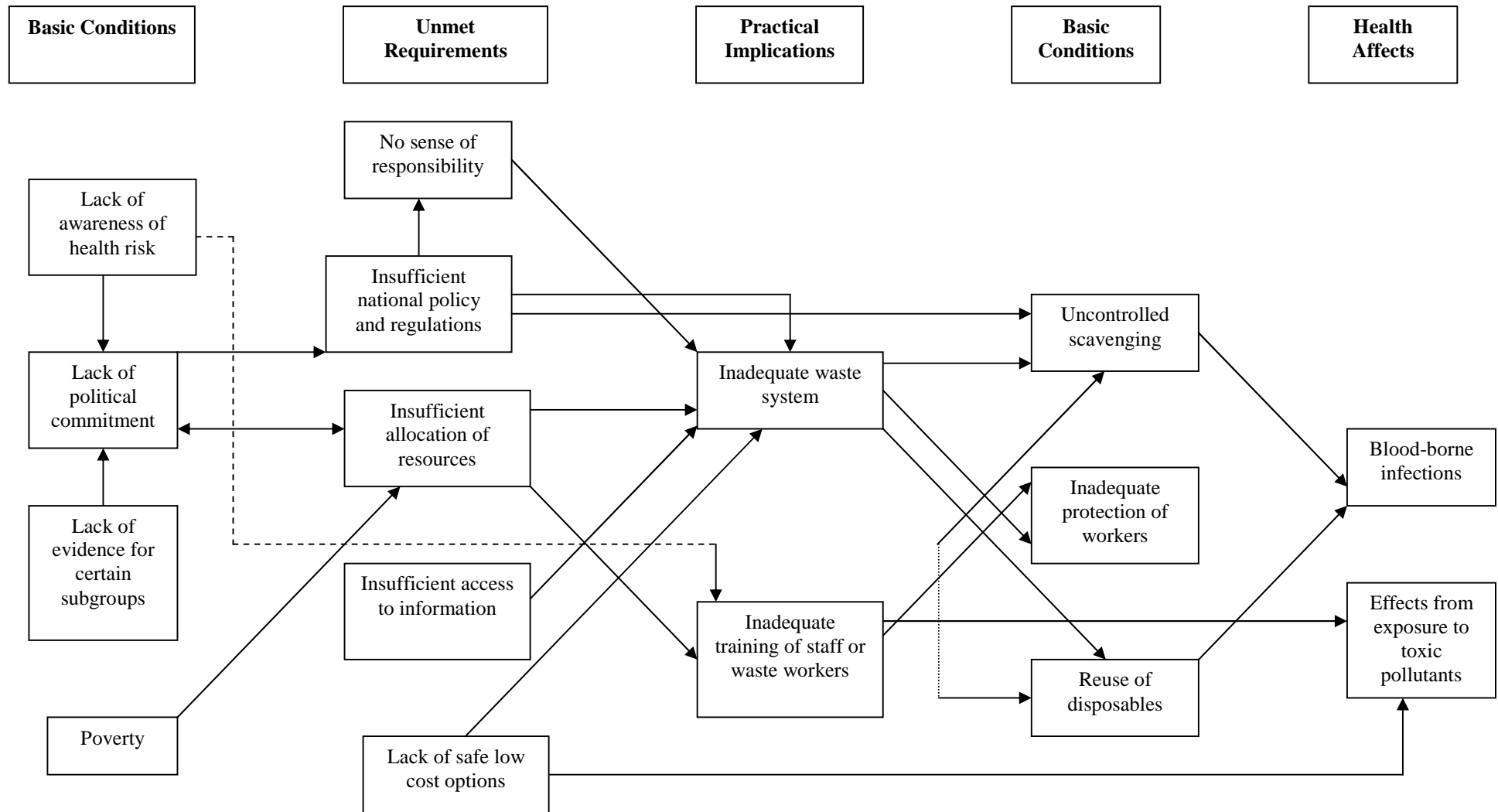


Figure 7: Interference of Causes and Effects of Inadequate Waste Management

(e) Economic constrains (f) Following the old management (g) Corruption of the lower level (h) Hazardous waste management is not high in the political agenda (i) Lack of responsibilities and supervision (j) Inadequate enforcement of existing pollution control laws.

According to Mobarak [18], private hospitals and clinics are better off than public hospitals/clinics because in public hospitals autocracy is practiced where policy makers are not interested to improve the hospital environment and follow the waste management procedures even if they are aware about it. He also said that the management of public hospitals is very poor as bureaucratic red tape plays a major role. According to the Conservator Officer of Dhaka City Corporation (DCC) treatments in private hospitals and clinics may be good but the waste disposal procedure is nothing different from the public hospitals. According to Dana [19], the main problem is the lack of awareness at all levels in this occupation and the management plan is so poor that hospital/clinical wastes are mixed with general wastes. According to PRISM the major reason for not being able to achieve a successful management system are: (a) First there is a system for medical waste management but no implementation (b) No effective measures taken by the authority to ensure that hospital follow the guideline (c) No provision of quantifying and record keeping on waste or any accident occurred (d) Some hospitals segregates waste in house but dumps together in DCC bin. (e) No provision for regular training and awareness among the staffs

The failure in hospital waste management has deeper implications than those mentioned above there is a generalized lack of interest in addressing waste management and in introducing safer healthcare waste management system [20]. In addition there are no appropriate regulations, or is there any enforcement. An essential issue was is the clear attribution of responsibility of appropriate handling and disposal of waste. According to the 'polluter pays' principle, this responsibility lies with the waste producer, usually being the health-care provider, or the establishment involved in related activities [8]. WHO [8] provides that in addition to the lack of political will to develop and implement a proper management system as it plays an important role on the management of health care wastes. The main relations between causes and effects are outlined in figure 7 [8]:

POLICY GUIDELINES AND LEGAL ASPECTS

The Medical Practice, Private Clinics and Laboratories (Regulation) Ordinance, 1982, amended in 1984, says nothing in particular about medical waste management. It describes some criteria for obtaining a license to establish a hospital or clinic, but this merely states the necessity for proper accommodation with hygienic environment.

The Environment Policy, 1992, Environment Protection Law, 1995 (2000), Poribesh Adalat Ain, 2000; and the Environment Conservation Rules, 1997 formulated by

the Department of Environment, Ministry of Environment and Forests categorize hospitals and clinics with other industries, saying that hospitals and clinics should be built only in non - residential areas, a directive which is hardly followed. The existing environmental law is too generic and it is clear that clinical waste requires separate environmental guidelines. The City Corporation Act and the Urban Local Government Ordinance does not cover medical waste management.

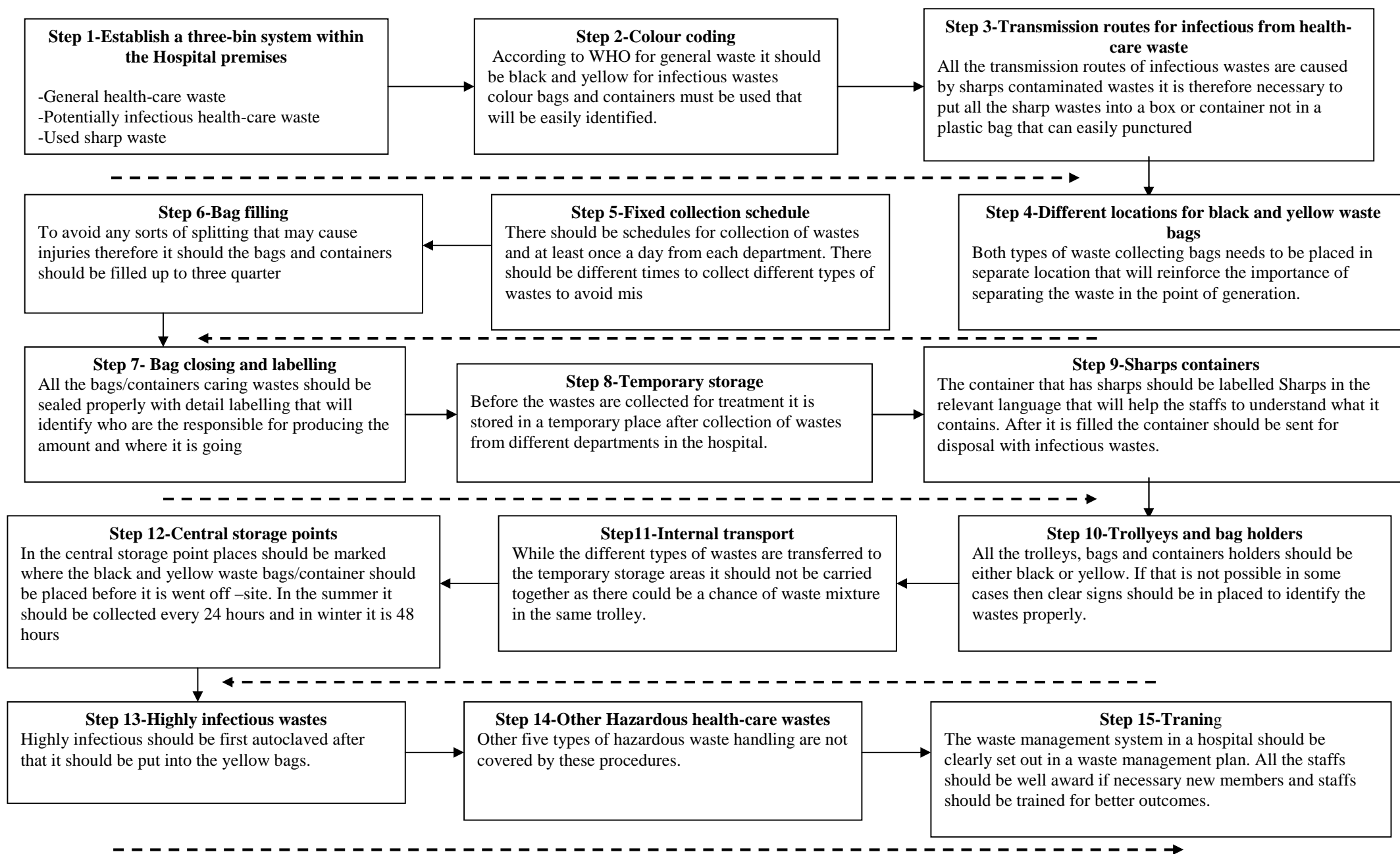
Some actions have however been taken. Very recently, a bill was prepared by the MoEF for amendment of the old ordinance for issuing licenses for private practice as well as for establishing new private health care centres and to control hospital waste. A committee was formed at the initiative of the Department of Environment involving representatives from relevant government agencies and other stakeholders. Under the Sustainable Environmental Management Programme (SEMP), there is provision of review and amendment for a range of environmental laws. The Department of Environment has outlined a guideline for medical waste management Rules 2008.

National law should consist of clear definitions, defined responsibilities duty of care of waste producer, tracking systems and record keeping, defined penalties, regulatory and enforcement systems. For clear definition some laws should be enacted. The laws are Framework Law on Environmental Protection, including environmental permitting, Law on Air, Law on Water Protection, Law on Nature Protection, and Law on Waste Management. The policy document should contain the following issues: (i) Description of health and safety risks (ii) Reasons for safe and sustainable health-care waste management (iii) Description of approved methods of waste minimization, handling and disposal (iv) Record keeping and documentation (v) Training

EFFECTIVE MANAGEMENT SYSTEM

The generation of medical waste in Bangladesh has been increasing in quantity and variety due to the wide acceptance of single-use disposable items. In the recent past, medical waste was often mixed with household waste and disposed of in municipal solid waste landfills [16]. Time has come that we need to give priority to medical waste management in Bangladesh. Therefore

for the improvement in hospital waste management series of small steps involved, which can be undertaken gradually. Since there is no 'one stop' technical solution considering the situation in Bangladesh to have effective management system the things we need to do first are as follows [21]: (a) Appoint a Hospital Waste Supervisor and allocate resources (b) Assess type and quantity, appraise current handling methods, evaluate treatment and disposal facilities (c) Encourage safe practices throughout the different stages of the waste life cycle (d) Require to regular training sessions for all staff

Figure 8: Step-by-Step Approach for Medical Waste Department

(e) Tax the polluter- implement “polluter pays” principle

Along with these we also develop a in-house management plan for all healthcare establishments. The hospital, clinic, diagnostic centres and other healthcare institutions must have a separate department for managing the medical waste. This department will be responsible for arranging create awareness, training, do regular monitoring and evaluate the system for updates. An attempt has been made in by identifying activities in figure 8 to develop a step by step approach for medical waste management department.

Currently increased interest on improper disposal of medical waste has led to a movement to regulate the medical waste more scientifically. We should try to minimize and recycle some of medical wastes before final disposal, if it is not infected or contaminated. Similar plan like PRISM could be used in medical waste treatment until which will be cheaper and effective. Emission of toxic substances from any healthcare establishment should be closely monitored to reduce potential risks to humans and the surrounding environment. Achieving a good standard of cleanliness in health-care institutions is an important component in controlling the infection. However at present there are practically no environmentally friendly, low-cost options for safe disposal of infectious hospital wastes. More research needs to be carried on hospital waste for better management of waste that will have less impact on the health of the human beings who are at risk.

RECOMMENDATION ON MEDICAL WASTE MANAGEMENT

Firstly we need to develop a national policy for safe health-care waste management Along with the policy we also need to keep in mind that in a country like Bangladesh where the waste handlers are illiterate, the hospital/clinical waste procedure should be very simple. The national policies should include the following issue: (a) The government should be wade accountable. (b) Development of an enforcement mechanism (c) Setting of practical targets or objectives over a specified time period (d) Establishment of a national and regional infrastructure for health-care waste disposal (e) Support of regional and municipal authorities in implementation (f) Integration of waste minimization into national purchasing policies (g) Routine monitoring of impact through process indicators (number of health-care establishments with safe waste management systems) and outcome indicators (e.g. number of accidents involving health-care waste).

However the waste management guidelines on hospital should include the following recommendations for effective hospital waste management system: (a) More emphasis should be on waste segregation at the source by introducing different colour code bags or containers that will help proper channelling of the hospital waste. (b) Hospital Authority should provide proper disposal site for the time being before any system developed (c) The City Corporation should take initiatives for regional waste treatment plan by providing places for medical waste dumping (d) The government needs to upgrade the waste disposal system and consider the international principles as their guideline for better practice in hospital waste management. (e) Strict law policy should be made and future plans of waste management should emphasis on waste tracking system. (f) Implement polluter pays principle where hospital should be pay for their wastes. (g) More private companies should be encouraged to come forward and take initiative to manage the medical wastes (h) The authority should have proper system for recycling of hospital waste and removal, (i) Build strong communication across the Ministry of family Welfare, Ministry of Environment, City Corporation Local authorities and NGOs should communicate for better waste management.

CONCLUSION

Hospitals in Bangladesh pose significant threat to health and environment on account of inadequate waste management need to raise awareness and provide educational training on medical waste management. Proper waste management policy is required to ensure health and environmental safety and it is recommended that simple changes in policy and support from government and private sectors would bring innovative changes in healthcare waste management. However the healthcare waste management guideline, planning and policy should be under the shadow of legislation, emphasis should be given in the development of educational training programme, record keeping, monitoring, review of existing situation and there should be collaboration between inter ministerial, hospital authorities, and active participation from the community.

Indeed a good number of organisations are working on Health Care Waste Management System. As such the situation has improved considerably in some part of Dhaka only but we are far from appreciation for the responsibility of medical doctors and management with respect to hospital waste. Now the task is for government to formulate appropriate policy with a manual that needs to be followed by all the hospitals, clinics and diagnostic centres in Bangladesh. Then, through training and guidance supported by DGHS and private (training) NGOs, the

application of guidelines and procedures associated with effective enactment of the law through DoE needs to be promoted. At the same time government and the private sector should create a central facilities for safe collection and final disposal of the clinical waste, through landfill, incineration or otherwise like PRISM Bangladesh.

REFERENCES

- [1] Secondary and Tertiary Health Care Facilities in Bangladesh 2010, (n.d) retrieve from: http://nasmis.dghs.gov.bd/dghs_new/dmdocuments/All/Secondary%20and%20Tertiary%20Care%20Facilities.pdf
- [2] International Centre for Diarrhoeal Research, Bangladesh (ICDDR, B) 1997, *An Interventory of health and Family Planning Facilities in Dhaka City*, MCH-FP Extention Project (Urban), Health and Population Division, ICDDR, B
- [3] Rahman, A.K.M., (ed.), 2000, *Situation Assessment and analysis of Hospital waste Management (A Piolt Study)*, Line Director, Hospital Services, DGHS, Dhaka
- [4] WHO 1999, *Safe Management of Wastes from Health-Care Activities* WHO, Geneva
- [5] WHO 2001, *Health-care Waste Management: Rapid Assessment Tool for Country Level*. World Health Organization: Geneva.
- [6] Pruss, A., Giroult, E., Rushbrook, P., 1999, *Safe Management of Waste From Healthcare activities*, WHO, Geneva.
- [7] WHO *Teacher's Guide Management of Wastes from Health-Care Activities* Geneva 1998
- [8] WHO 2000, *Hospital Waste Management Problems and Strategic Solution, an Insight'*.
- [9] Decision Making Guide for Managing Healthcare Waste from Primary Healthcare Centres, Draft Document 2002, retrieve from: http://www.int/water_sanitation_health/Environment_sanit/Healtcare_waste/decision.htm
- [10] DGHS *Manual for Hospital Waste Management*, 2001.
- [11] Akther, N., 2000 Medical waste Management Review, In Ahmed., ed. *Bangladesh Environment 2000 [an outcome of ICBEN-2000]*, BAPA, Dhaka..
- [12] Rashbrook, P., 2000, *Starting Healthcare Waste Management in Medical Institution, (A Practical Approach)* WHO, retrieve from: http://www.healthcarewaste.org/linked/onlinedocs/HCW_practicalinfo1.pdf
- [13] DGHS *Medical waste Management Rules 2008*.
- [14] DGHS, *Hospital Waste Management Pocket Book June 2010*
- [15] Rahman, H.M., Ahmed, S.N. and Ullah, S.M., 1999, *A Study on Hospital Waste Management in Dhaka City, Integrated Development for Water Supply and Sanitation*, retrieve from: <http://www.healthcarewaste.org/linked/countryinfo/Asia/BD/Bangladesh1.pdf>
- [16] Hassan M M., Ahmed S. A., Rahman K A., and Biswas T. K., 2008 Pattern of medical waste management: existing scenario in Dhaka City, Bangladesh in *Public Health*, doi, [10.1186/1471-2458-8-36](https://doi.org/10.1186/1471-2458-8-36).
- [17] Waste Concern 2002 (unpublished) *Manual on Bio-Medical Waste Management*,
- [18] Mubarak, R., 1998, *Hospital Environment in Dhaka*, Research paper, BCAS, Bangladesh
- [19] Dana Tabassum, 1999, *Hospital Waste Disposal An Exploration in Search of Policy, Guidelines and Rules*, Bangladesh Legal Aid and Services Trust (BLAST).
- [20] Hildebranda, A.V., 2000, *A short Overview of health care Waste Management, with Emphasis on Syringe Disposal*, Searo and WHO.
- [21] DGHS 2000, *Situation Assessment & Analysis of Hospital Waste Management (Pilot Study)*,