BIOMEDICAL WASTE MANAGEMENT IN NEPAL : A REVIEW

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ABSTRACT

Medical waste management is of great importance due to its infectious and hazardous nature that can cause undesirable effects on humans and the environment. A rapid increase in the number of hospitals in the public and private sectors has made a significant generation of hospital waste. Improper waste segregation, handling, transport and treatment leads to direct adverse effects on health and environment. The aim of this paper is to highlight the present condition of medical waste in Nepal and a review on scientific method of hospital waste management.

KEY WORDS: Hospital waste management, Medical waste in Nepal

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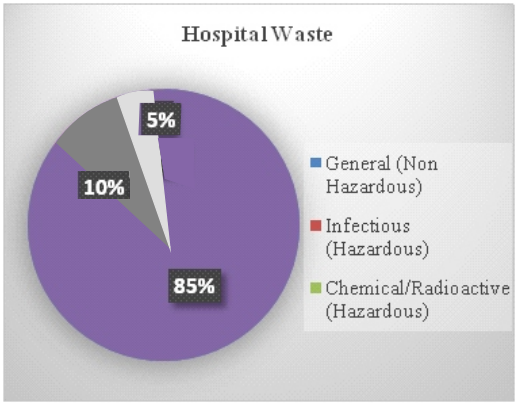
INTRODUCTION

Biomedical waste is defined as any waste material generated during diagnosis, treatment and immunization of human beings or animals with potential health and environment risks.[1] Hospital waste refers to all waste generated, discarded and not intended for further use in the hospital. The risks are not only connected to the handling of the waste, both inside and outside the health care facilities but also the environmental risk connected to the treatment and disposal of the waste. The health care waste management issue is becoming important in view of increased health care waste risk and fast increasing HIV/AIDS incidence among certain groups, calling for increased attention to blood safety, disposal of needles and syringes and other infectious waste. World health organization (WHO) states that 85% of hospital wastes are actually non-hazardous, around 10% are infectious and around 5% are non-infectious but hazardous wastes.[2,3]

Figure 1: Classification of hospital waste.[3]



Management of healthcare waste in hospitals is important as they are responsible for many infections as well as chemical and radioactive injuries. Biomedical waste can be classified as sharps (needles or scalpels), pathological wastes (body parts, cultures and blood samples) and infectious wastes (items contaminated with body fluids and discharges such as dressing, catheters and I.V. lines).[1] Other wastes generated in healthcare settings are radioactive wastes, mercury containing instruments and polyvinyl chloride (PVC) plastics.

The management of bio-medical waste is still in its infancy all over the world. There is a lot of confusion with the problems among the generators, operators, decision-makers and the general community about the safe management of biomedical waste. The reason may be a lack of awareness. Hospitals are responsible for the waste they generate. They must ensure that handling, treatment and disposal of that waste will not have harmful consequences to the public health. The main aim should be on reducing the infectious and hazardous waste to less than 15% with proper segregation, transport and treatment of the waste.

SOURCES OF BIOMEDICAL WASTE

Biomedical waste is generated primarily from health care establishments, including hospitals, nursing homes, veterinary hospitals, clinics and general practitioners, dispensaries, blood banks, animal houses and research institutes. The other sources of biomedical waste are households, industries, education institutes and research centres, blood banks and clinical laboratories, health care for humans and animals.[3]

CLASSIFICATION OF HOSPITAL WASTE

Hospital care waste has been classified in different categories for scientific method of segregation, transportation and disposal/treatment (Table 1).

Table 1: Classification of biomedical waste[3-6]

Category	Waste Content	Components
Category No. 1	Human Anatomical Waste	Human tissues, organs, body parts
Category No. 2	Animal Waste	Animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals/colleges, discharge from hospitals, animal and houses
Category No 3	Microbiology & Biotechnology Waste	Wastes from laboratory cultures, stocks or specimens of micro- organisms, live or attenuated vaccines, human and animal cell culture used in research, infectious agents and industrial laboratories, wastes from production of biologicals, from research toxins, dishes and devices used for transfer of cultures
Category No. 4	Waste sharps	Needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. It includes both used and unused sharps
Category No. 5	Discarded Medicines and Cytotoxic drugs	Wastes comprising of outdated, contaminated and discarded medicines
Category No. 6	Solid Waste	Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood
Category No. 7	Solid Waste	Wastes generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets, etc.
Category No. 8	Liquid Waste	Waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities
Category No. 9	Incineration Ash	Ash from incineration of any biomedical waste
Category No. 10	Chemical Waste	Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.

AMOUNT AND COMPOSITION OF HOSPITAL WASTE GENERATED

(a) Amount: The quantity of waste produced in a hospital depends on the level of national income and the type of facility concerned. Healthcare waste generation in high-income Asian countries varies from 2.5 to 4 kg/bed/day while it is 1.8 to 2.2

kg/bed/day in low-income countries (Table2). Public hospitals generate high proportion of total health care wastes in comparison with private hospitals. The amount of waste was positively correlated with the number of patients in a research study done in six hospitals of Ethiopia.[7]

Table 2: Hospital waste generation in South Asian countries [8-13]

Country	Quantity (kg/bed/day)
Bangladesh	0.8-1.67
Bhutan	0.27
India	1-2
Nepal	0.5
Pakistan	1.63-3.69
Srilanka	0.36

(b) Composition

The solid waste from hospitals consists of bandages, linen and other infectious wastes (30-35%), plastics (7 -10%), disposable syringes (0.3-0.5%), glass (3-5%) and other general wastes including food (40-45%).

RISKS AND IMPACT OF HOSPITAL WASTE ON HEALTH AND ENVIRONMENT

One should note that only 15% of biomedical waste is hazardous, not the complete. But when hazardous waste is not segregated at the source of generation and mixed with non-hazardous waste, then 100% waste becomes hazardous.

WHO IS EXPOSED ?

The following groups of persons are potentially exposed:

a) Inside the hospital: care staff (doctors, nursing staff, auxiliaries), stretcher-bearers, scientific, technical and logistic personnel (cleaners, laundry staff, waste managers, carriers, maintenance personnel, pharmacists, laboratory technicians, patients, families and visitors)

b) Outside the hospital: off-site transport personnel, personnel employed in processing or disposal infrastructures, the general population (including adults or children who salvage objects found around the hospital or in open dumps).

RISKS ASSOCIATED WITH HAZARDOUS MEDICAL WASTE

The various risk associated with hazardous medical waste are summerized in box 1.

Box 1: Health risks associated with hazardous medical waste

- ✓ Risk of trauma
- ✓ Risk of infection
- ✓ Chemical risk (genotoxic or cytotoxic)
- ✓ Risk of fire or explosion
- ✓ Risk of radioactivity
- ✓ Risks with sharps
- ✓ Hazards from health care treatment methods

1. RISKS OF TRAUMA AND INFECTION

There are many different exposure routes: through injury (cut, prick), through contact with the skin or mucous membranes, through inhalation or through ingestion favouring entry of micro organisms. A study conducted by the WHO in 1996 suggests that more than 50,000 people die every day from infectious diseases caused by improper waste management. Common infectious diseases are tuberculosis, pneumonia, HIV, diarrhoeal diseases, tetanus, whooping cough, anthrax etc. [14-16]

2. HAZARDS FROM CHEMICAL AND PHARMACEUTICAL WASTE

Many of the chemicals and pharmaceuticals used in health care are hazardous:

2.1. Mercury: Mercury is highly toxic, especially in elemental form or as methyl mercury. It may be fatal, if inhaled and harmful, if absorbed through the skin. The nervous, digestive, respiratory and immune systems and kidneys can be harmed, as well as the lungs. Adverse health effects from mercury exposure can be tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during fetal development, attention deficit and developmental delays during childhood.[17]

2.2. Silver: Silver can turn a person's skin permanently grey and can develop a resistance to antibiotics. [18]

2.3. Disinfectants: Chlorine and quaternary ammonium are used in large quantities in health-care facilities and are corrosive. Where chlorine is used in an unventilated place, chlorine gas is generated as a by-product of its reaction with organic compounds.

2.4. Pesticides: Poisoning can occur through direct contact with a pesticide formulation, inhalation of vapours, drinking contaminated water or eating contaminated food.

3. HAZARDS FROM GENOTOXIC WASTE

Many antineoplastic drugs are carcinogenic and mutagenic.

4. HAZARDS FROM RADIOACTIVE WASTE

These types of waste can cause headache, dizziness and vomiting to much more serious problems. Radioactive waste is genotoxic, and a sufficiently high radiation dose may also affect genetic material and cause tissue destruction.

5. HAZARDS ASSOCIATED EVEN AFTER WASTE DISPOSAL

Although treatment and disposal of health-care wastes aim at reducing risks, indirect health risks may occur through the release of toxic pollutants into the environment through treatment or disposal.

a) Landfilling can lead to contamination of drinking water.
b) Occupational risks may be associated with the operation of certain disposal facilities.
c) Inadequate incineration, or incineration of materials unsuitable for incineration can result in the release of pollutants into the air. The incineration of materials containing chlorine can generate dioxins and furans, which are potential carcinogens.[19-26]
d) Incineration of heavy metals or materials with high metal contents (lead, mercury and cadmium) can lead to the spread of heavy metals in the environment. Dioxins, furans and metals are persistent and accumulate in the environment. Only modern incinerators which are able to work at 800-1000°C with special emission cleaning equipment can ensure that no dioxins and furans (or only insignificant amounts) are produced.

STATUS OF HOSPITAL WASTE MANAGEMENT IN NEPAL

In Nepal, there were no specific national policies on the waste management till 1996. Although solid waste was addressed in the eighth, ninth and tenth plan of Nepal Government, the polices were almost non-functional. The three year Interim Plan of Nepal Government (2064/65 B.S- 2066/67 B.S) mentioned the programs for Health Care Waste Management.[27] Nepal Health Research Council in collaboration with Ministry of Health (MOH) and WHO has developed National Health Care Waste Management (HCWM) guidelines and a Training Manual for Medical Professionals.

Health Care foundation Nepal (HECAF) is another organization which has been working in the field of waste care management since 1999, when it installed the first waste care management system in National Kidney Centre. HECAF developed its first HCWM programme in 2007 and works closely in consultation with Department of health services (DOHS) and provides information, education and communication (IEC) materials on health care management. HECAF is also a member of Health care without harm (HCWH), which is an international coalition of hospitals, professionals and Non-Governmental Organizations (NGOs). HCWH provides technical support to HECAF in managing hospital care waste. WHO has also endorsed and supported HECAF on health care management in Nepal.[28] The first survey on HCW management conducted in 11 hospitals in the Kathmandu Valley (1997) found 0.54 kg /patient/day of HCW where as health care risk waste (HCRW) was 0.16 kg/patient/day.

Another survey was conducted in 2001 by the Environment & Public Health Organization(ENPHO) for the Kathmandu Valley Mapping Program, Kathmandu Metropolitan City which demonstrated 1.7 kg/person/day of health care waste (HCW) and 0.48 kg/person/day of health care risk waste (HCRW) at an average bed occupancy rate of 65%[29] whereas in a study done by HECAF (2010) in Bir hospital, Kathmandu found hospital waste of 1.23 kg/bed/day.

Table 3: Amount of HCW in different Health Care Institutions (at bed occupancy rate 60.7±20.8)[30]

Types of waste	General waste (%)	Hazardous (%)	Sharps (%)
Patan Hospital	63.5	27.8	8.8
National kidney centre	50	17	33
Koshi zonal Hospital	68.4	28.4	3.1

Studies done at three major hospitals in Nepal show that there is increased generation of hazardous and sharp wastes which exposes the health care worker to infections and injuries (Table 3). [30] Proper Health care waste disposal in Nepal by providing knowledge and awareness is today`s necessity to fulfil the WHO guidelines of proper waste disposal and management. A study done by Paudel et al. showed that health care waste management practice in the hospital was unsatisfactory because of the lack of waste management plan and carelessness of patients, visitors and staffs.[31] Therefore, the hospitals should develop the waste management plan and strictly follow the National Health Care Waste Management Guidelines.[30]

WHY PROPER HOSPITAL WASTE MANAGEMENT IS NECESSARY ? (Table 4)

Table 4: Aims of proper waste management

Proper waste management aims in preventing:

- ✓ Injuries from sharps leading to infection to health personnel and waste handler.
- ✓ Nosocomial infections in patients from poor infection control practices and poor waste management.
- ✓ Risk of infection outside hospital for waste handlers and scavengers and at time general public living in the vicinity of hospitals.
- ✓ Risk associated with hazardous chemicals, drugs to persons handling wastes at all levels.
- ✓ "Disposable" being repacked and sold by unscrupulous elements without even being washed.
- ✓ Drugs which have been disposed of, being repacked and sold off to unsuspecting buyers.
- ✓ Risk of air, water and soil pollution directly due to waste, or due to defective incineration emissions and ash.

APPROACH FOR HOSPITAL WASTE MANAGEMEN T

A number of papers have been published on proper segregation, collection, transport and treatment of biomedical waste. It is also found that health workers have poor knowledge and awareness on biomedical waste generation hazards, legislation and management.

1. Segregation of waste

The current waste management practice observed at many hospitals is that all wastes, potentially infectious, office, general, food, construction debris, and hazardous chemical materials are all mixed together as they are generated, collected, transported and finally disposed of. As a result of this there is failure of segregation of wastes as a whole which is both potentially infectious and hazardous (chemicals). The workers who handle the wastes (hospital workers, municipal workers) are at greater risks. General public can be affected due to accidental exposure from contact with wastes at municipal disposal bins, exposure to chemical or biological contaminants in water and exposure to chemical pollutants (e.g., mercury, formaldehyde, Poly vinyl chloride) from incineration of the wastes.

Segregation is done at the source of generation of biomedical waste e.g., all patient care activity areas, diagnostic services areas, operation theatres, labour rooms, treatment rooms, procedure rooms etc. The responsibility of segregation should be with the generator of biomedical waste i.e., doctors, nursing staffs, technicians etc. (medical and paramedical personnels). The biomedical waste should be segregated as per categories mentioned in the rules.

Imposing segregation practices within hospitals to separate biological and chemical hazardous wastes (less than 10% of the waste stream) will result in a clean solid waste stream (90%) and reduce the quantity which can be easily, safely and cost-effectively managed through recycling, composting and land filling the residues.

2. Collection of bio-medical waste

Collection of bio-medical waste should be done as per Biomedical waste (Management and Handling) Rules (Table 5).[4] At ordinary room temperature the collected waste should not be stored for more than 24 hours.

Table 5: Colour coding for collection of biomedical waste

Colour coding of polyethylene bag	Type of waste material collected
	Non-infectious and non-hazardous waste
Red	Microbiological waste from pathological laboratory, items contaminated with blood and body fluids, and waste generated from disposable items other than sharps, etc.
Yellow	Human anatomical waste, microbiological waste from pathological laboratory, items contaminated with blood and body fluids, and waste generated
Blue	Waste sharps, solid waste generated from disposable items other than the waste sharps such as tubing, catheter, IV sets, etc.

3. Proper sharps management system

Indiscriminate disposal of sharps (needles, syringes, lancets, and other invasive tools) is hazardous. Proper segregation of these materials in rigid, puncture proof containers with safe treatment and disposal should be carried out in any health care institution. If proper sharps management are practised in all health care facilities, most of the risk of disease transmission from medical waste would be solved. It includes proper equipment and containers distributed everywhere the sharps are generated (needle cutters and needle boxes).

4. Waste minimization

Hospitals of developing countries produce less amount of waste in comparison to western hospitals. Special emphasis should be given while purchasing hospital products. Mercury-based products (thermometers, sphygmomanometer) should be replaced by digital and electronic products because many developing countries have no capacity to safely manage mercury wastes; the reduction policy will make a serious contribution in cleaning up the hospital waste.

Some of the methods that should be applied are given in box 2.

Box 2: Practices that encourage waste minimization

1. **Source reduction**
   - Purchasing reduction: selection of supplies that are less wasteful and less hazardous
   - Use of physical rather than chemical cleaning methods (steam disinfection in place of chemical disinfection)
   - Prevention of wastage of products in nursing and cleaning activities
2. **Stock management of chemical and pharmaceutical products**
   - Frequent ordering of small quantities rather than ordering large amount at one time
   - Use of oldest batch of product first
   - Use of all the contents of the container
   - Checking out the expiry dates of all the products at the time of delivery

5. Transportation

Within hospital, waste routes must be planned to avoid the passage of waste through patient care areas. Alternate time should be earmarked for transportation of biomedical waste to reduce chances of its mixing with general waste. Desiccated wheeled containers, trolleys or carts should be used to transport the waste/plastic bags to the site of storage/ treatment.

Trolleys or carts should be thoroughly cleaned and disinfected in the event of any spillage. The wheeled containers should be so designed that the waste can be easily loaded, remains secured during transportation, does not have any sharp edges and is easy to clean and disinfect. Hazardous biomedical waste needing transport to a long distance should be kept in containers and should have proper labels. The transport is done through desiccated vehicles specially constructed for the purpose having fully enclosed body, lined internally with stainless steel or aluminium to provide smooth and impervious surface which can be cleaned. The driver's compartment should be separated from the load compartment with a bulkhead. The load compartment should be provided with roof vents for ventilation.

6. Treatment of hospital waste

Treatment of waste is required to disinfect the waste so that it is no longer the source of infection, reduce the volume of the waste, make waste unrecognizable for aesthetic reasons and make recycled items unusable.

a) General waste (85% of hospital waste)
   Safe disposal of this waste is necessary which the responsibility of the local authority.
b) Biomedical waste (15% of hospital waste)

The methods of treatment and disposal of biomedical waste as per their categories with their advantages and disadvantages are given in Table 6 and Table 7.

Table 6: Methods of treatment of HCWs

Category	Waste Content	Method of treatment and disposal
Category No. 1	Human Anatomical Waste	Incineration /deep burial
Category No. 2	Animal Waste	Incineration /deep burial
Category No 3	Microbiology & Biotechnology Waste	Local autoclaving/ microwaving/ incineration
Category No. 4	Waste sharps	Disinfections/chemical treatment/autoclaving/microwaving and mutilation shredding
Category No. 5	Discarded Medicines and Cytotoxic drugs	Incineration/destruction & drugs disposal in secured landfills
Category No. 6	Solid Waste	Incineration, autoclaving/ microwaving
Category No. 7	Solid Waste	Disinfections chemical treatment/autoclaving/microwaving and mutilation shredding
Category No. 8	Liquid Waste	Disinfections by chemical treatment and discharge into drains
Category No. 9	Incineration Ash	Disposal in municipal landfill
Category No. 10	Chemical Waste	Chemical treatment and discharges into drains

Advantages and disadvantages of different methods of treatment

Table 7: Advantages and disadvantages of different methods of waste treatment

[Source: Healthcare without Harm (2001); WHO (1999)

Treatment methods	Advantages	Disadvantages
Incineration	• Reduction of waste volume and weight • Acceptability for all waste types • Heat recovery potential	• Public opposition, larger space and footprint required • High investment and operation cost • Formation of dioxins and furans linked to serious health problems including cancer • High maintenance, testing and repair cost • Vulnerability to future stringent emissions standards
Autoclave Disinfection	• Encourages reuse and recycling • Commercially available • Low investment and operating cost • Easy to operate • Creation of residue that is less hazardous than incineration	• Inability to change waste volume andwaste appearance • Lack of suitability for some wastetypes *e.g. low level radiation, toxiccontaminant* • Production of uncharacterized airemissions and odor problems
Microwave Disinfection	• Significant volume reduction • Absence of liquid discharges	• High investment cost and increased waste weight • Lack of suitability for some waste types • Potential to expose workers to contaminated shredder • Production of uncharacterized air emissions
Chemical Disinfection	• Significant waste volumereduction • Ability to make wasteunrecognizable and easy to use • Waste deodorization • No combustion by-products	• Possible toxic by-products inwastewater • Lack of suitability for some waste types • Production of uncharacterized air emissions • Need for chemical storage and use
Plasma pyrolysis	• Suitable for all types of wasteand results in reductions up to80-90% in volume and in weight	• Suitable for very large hospitals and regional treatment facilities • Still at the demonstration scale

7. Safety measures

All the generators of biomedical waste should adopt universal precautions and appropriate safety measures while doing therapeutic and diagnostic activities and also while handling the biomedical waste.

It should be ensured that:
- Person involved on collecting and carrying waste are aware of the nature and risk of the waste.
- Written instructions, provided regarding the procedures to be adopted in the event of spillage and/or accidents.
- Vaccination against infectious diseases (Hepatitis B, tetanus) is given.

8. Education and training

Workers handling hospital wastes are at greatest risk from exposure to the potentially infectious wastes and chemical hazardous wastes without proper knowledge of the exposure risks or access to necessary protective gear. A study done in Gujrat showed that though the doctors knew about the hazards of improper management of biomedical wastes, they were unaware of the different methods used for their treatment and disposal. The paramedics had poor knowledge on infections that could be associated with poor management of waste.[32] A descriptive observational study done with 200 junior doctors in West Bengal, India showed that only 29.5% had the knowledge of various methods of final disposal of BMW and only 76.4% knew about various types of color-coded bags for collection of BMW.[33]

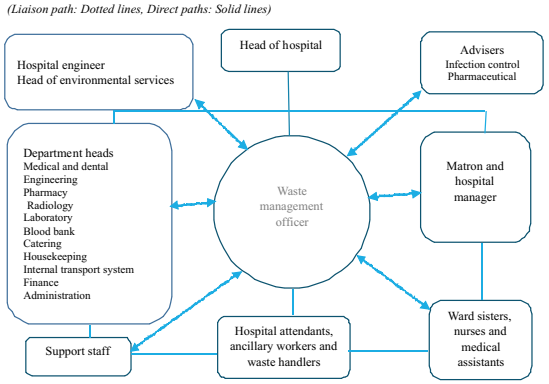
Proper education and training must be given to all workers from doctors, ward boys, labourers and rag pickers regarding the risks and ability to manage wastes (especially how to properly segregate). Impact of intervention on healthcare waste management practices in a tertiary care governmental hospital of Nepal also showed positive results.[34]

This demands all hospitals to have well planned training programmes for all category of personnel including administrators (medical, paramedical and administrative).

9. Management and administration (Plans and policies)

Each hospital should constitute a hospital waste management committee, chaired by the head of the institute and having wide representation from all major departments (Fig.2). Health care institutions should develop clear plans and policies for the proper management and disposal of wastes integrated into routine employee training, continuing education, and hospital management which should be governed by the committee. Proper supervision, monitoring and implementation of the action plan on management of hospital waste should be carried out. The annual reports, accident reports, training schedules etc. should be submitted to the committee.[35]

Figure 2: Hospital waste management system [adapted from WHO WPR (1994)]



10. Coordination between hospital and outside agencies

- Coordination with municipal authority: As a large percentage of waste (85%) generated in hospitals, belong to general category (non-toxic and non-hazardous), hospitals should have constant interaction with municipal authorities for regular collection, land filling and treatment of the waste.
- Co-ordination with Pollution Control Boards, Organizations working on HCW management and NGOs: Proper coordination is required to search for cost effective and environmental friendly technology for treatment of biomedical and hazardous waste.

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