Healthcare Waste Management in South Asia

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1. Overview of Healthcare Waste Management

World Health Organization (WHO) defines healthcare waste as total waste generated by hospitals, healthcare establishments, and research facilities in the diagnosis, treatment, or immunization of human beings or animals, and other associated research and services. The major fraction (75-90%) of the waste generated by health-care facilities are, in general, non-risk waste and resembles residential and institutional waste. The remaining fraction (10-25%) is hazardous (risk) and may pose a variety of health risks (WHO, 1999). The hazardous healthcare waste can be categorized into different groups as presented in Table 1.

Table 1: Healthcare waste categories and description

Waste category	Description and examples
Infectious waste	Waste suspected of containing pathogens *e.g. laboratory cultures, waste from isolation wards, tissues, materials or equipment having been in contact with infected patients, excreta*
Pathological waste	Human tissue or fluids *e.g. body parts, blood and other body fluids, human fetuses*
Sharps	Sharp waste *e.g. needles, infusion sets, scalpels, knives, blades, broken glass, etc.*
Pharmaceutical waste	Waste containing pharmaceuticals *e.g. pharmaceuticals which are expired or no longer needed, items contaminated or containing pharmaceuticals (bottles, boxes)*
Genotoxic waste	Waste containing substances with genotoxic properties *e.g. waste containing cytotoxic drugs (often used in cancer therapy), genotoxic chemicals*
Chemical waste	Waste containing discarded chemical substances *e.g. laboratory reagents, film developer, disinfectants which are expired or no longer needed, solvents*
Wastes with high content of heavy metals	*e.g batteries, broken thermometers, blood pressure gauges*

Pressurized containers	*e.g. gas cylinders, cartridges and aerosol cans*
Radioactive waste	Waste containing radioactive substances *e.g. unused liquids from radiotherapy or laboratory research, contaminated glassware, packages or absorbent paper, urine and excreta from patients treated or tested with unsealed radionuclides*

Source: WHO (1999)

The hazardous clinical wastes poses risk to individuals exposed to such wastes, both within and outside establishments, workers in waste disposal facilities and scavengers. Potential hazards associated with these wastes, especially their effects on human health are paramount (Table 2). It is, therefore, necessary to examine such hazardous wastes from broader perspectives; from generation to collection, storage and disposal.

Table 2: Health effects and potential hazards from clinical wastes

Potential hazards	Health effects
Infectious agents	Respiratory infections, genital infections, skin infections, meningitis, AIDS, Viral Hepatitis A, B and C
Radioactive	Cancer, burn and skin irritation, headache, dizziness, and vomiting
Sharps	Double risk: injury and potential transmission routes for HIV and Hepatitis B and C from contaminated sharp
Pressurized containers	Injury from explosion
Hazardous chemicals	Intoxication, burns and skin irritation, pollution of groundwater, surface water and the air, possibility of fire, poisoning
Pharmaceuticals	Ineffective medical care from consumption of expired pharmaceuticals, pollution of groundwater, surface water and air
Genotoxic waste	Carcinogenic and mutagenic, skin or eyes irritation, nausea, headache, or dermatitis

Source: WHO (1999)

2. Generation, Collection, Storage and Transportation

2.1 Waste Generation

The quantity and composition of healthcare waste varies between and within countries. This variation can be attributed to the size of establishments, proportion of in and out-patients, type of institution and specialization, available waste segregation options, proportion and use of reusable items, wealth of user, and the prosperity of the country. Generally, low and middle-income countries generate low healthcare waste compared to high-income countries. 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. In North America, specific waste generation is as high as 7-10 kg/bed/day (WHO, 1999).

Similarly, the composition of the waste varies depending upon the country's economy. Composition of healthcare waste in developing countries is presented in Figure 1.

2.2 Waste Collection Guidelines

Collection of healthcare wastes is to be done separately to facilitate easy storage, transportation and treatment. Some guidelines for medical waste collection as recommended by WHO is given below.

- Daily or frequent collection and transportation of the waste to the storage.
- Bags are to be labeled with their point of production (hospital and ward or department) and contents. Unlabelled bags are not to be collected.

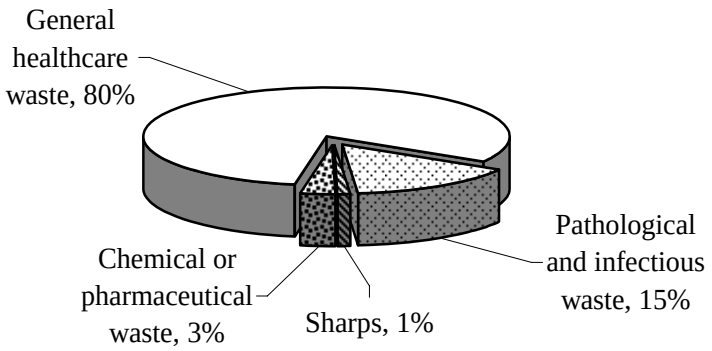

Figure 1: Healthcare waste composition in developing countries

- Bags or containers are to be replaced immediately with new ones of the same type which should be readily available at the source of origin.
- Bags and containers for infectious waste are to be marked with the international "Infectious Substance" symbol.
- Highly infectious waste should, whenever possible, be sterilized immediately by autoclaving. Red bags are recommended for autoclaving.
- Obsolete and expired pharmaceuticals are required to be returned to the pharmacy for disposal.
- Separate collection of waste with high heavy metals content (e.g. cadmium or mercury).

2.3 Storage Guidelines

It is essential to have a designated storage location within the healthcare establishment. Table 3 presents some of the recommended color coding techniques and types of containers to be used for storage (Figure 2). WHO recommended guidelines for healthcare waste are:

- Storage: An impermeable, hard-standing floor with good drainage, and an adequate water supply to clean and easy to disinfect.

Table 3: Recommended color coding for various wastes

Type of waste	Color of container and markings	Type of container
Highly infectious waste	Red	Strong leak-proof plastic bag or container capable of being autoclaved
Other infectious waste, pathological and anatomical waste	Yellow	Leak-proof plastic bag or container
Sharps	Yellow, marked "SHARPS"	Puncture-proof container
Chemical and pharmaceutical waste	Brown	Plastic bag or container
Radioactive waste	-	Lead box, labeled with the radioactive symbol
General healthcare waste	Black	Plastic bag

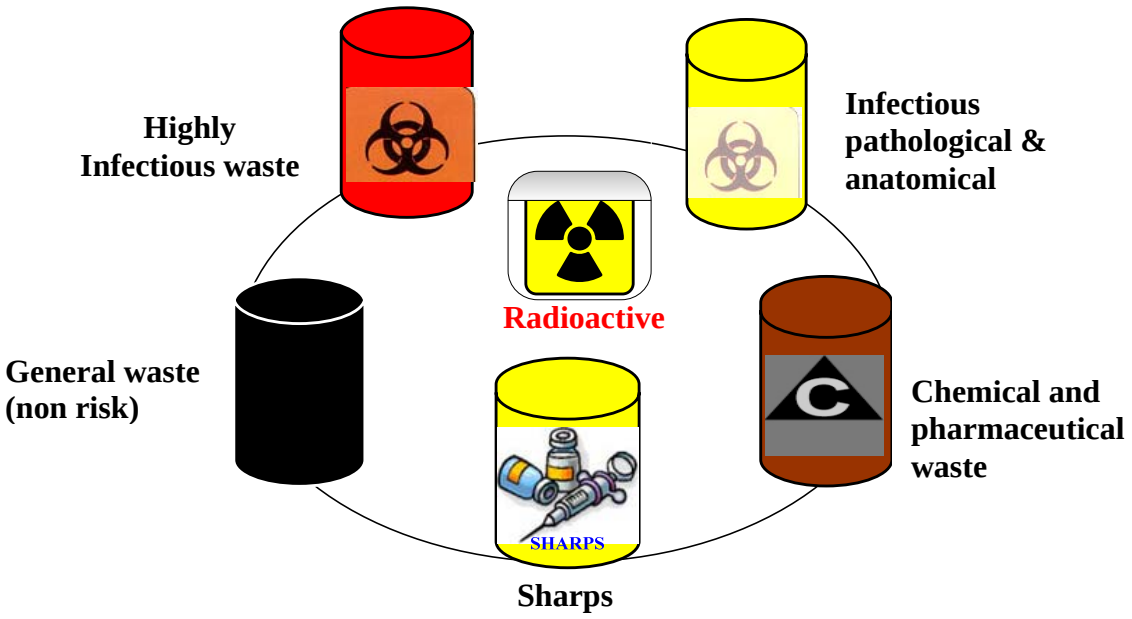

Figure 2: Collection containers with different color coding and labeling

- Good lighting and at least passive ventilation and protection from the sun.

- Storage area should not be situated in the proximity of fresh food stores or food preparation areas.

- Supply of cleaning equipment, protective clothing and waste bags or containers should be located conveniently close to the storage area.

2.4 Transportation Guidelines

The WHO guidelines for transportation of healthcare waste are:

- Transportation of medical waste within the medical institution i.e., from the point of generation to storage can be done by small trolleys or carts.
- The wastes transportation may be done during less busy hours, and through routes which are less prone to people.

- Transportation from the point to the onsite or external treatment facility can be done by specialized trucks marked with symbols denoting the type of waste carried.

- Suitable licenses should be provided for hazardous and low-level radioactive wastes. The driver of the vehicle should be knowledgeable of medical waste and the measures to be taken in case of an accidental spillage.

The vehicle used for transporting healthcare waste should not be used for any other material and should clearly be marked with the contact details and /address of the service provider. The route used for transporting healthcare waste to the treatment plant should be planned before and transported as quickly as possible to prevent any radiation which would affect the public.

3. Treatment Technologies

Although treatment technologies and disposal methods differ for each type of waste, segregation at source into different categories reduces the management, operation and treatment costs along with the risk of infection with these contaminants. WHO recommended treatment options for each category of waste as presented in Table 4. It is to be noted that no single technology is ideal for all kinds of bio-medical waste and for all scales of operation. Commonly used technologies are incineration, landfilling, burning, autoclaving and chemical treatment. Microwave disinfections, plasma touch technique, detoxification, and advanced wet oxidation are some emerging technologies. A new solar treatment technology developed in India is presented in Box 1.

Table 4: Treatment options for each category of waste

Options	Infectious	Anatomical	Sharps	Pharmaceutical	Cytotoxic	Chemical	Radioactive
Rotary kiln	✓	✓	✓	✓	✓	✓	Low-level
Pyrolytic incinerator	✓	✓	✓	Small quantities	X	Small quantity	Low-level
Single-chamber	✓	✓	✓	X	X	X	Low-level
Drum or brick incinerator	✓	✓	✓	X	X	X	X
Chemical disinfection	✓	X	✓	X	X	X	X
Wet thermal treatment	✓	X	✓	X	X	X	X
Microwave irradiation	✓	X	✓	X	X	X	X
Encapsulation	X	X	✓				X
Safe burial on hospital premises	✓	✓	✓	Small quantity	X	Small quantity	X
Sanitary landfill	✓	X	X	Small quantity	X	X	X
Inertization	X	X	X	✓	✓	X	X
Other methods				Return expired drugs to supplier	Return expired drugs to supplier	Return unused chemicals to supplier	Decay by storage

Source: WHO (1999) *✓= Recommended; X= Not recommended*

Box 1: Ecofriendly Medical Waste Disinfection: Solar Treatment

- Choithram Hospital and Research Centre India has developed a box-type solar cooker that disinfects waste by exposing it to the sun's ray.
- It consists of upper cover which supports reflecting mirror and lower metal box. Waste is fed into box with water and exposed to Sun rays for 6 hours
- Though it is unable to completely destroy all bacteria, level of bacterial reduction seems satisfactory.
- It is found beneficial for developing country for small scale operation in rural areas despite its inability to kill heat resistant bacteria.
- Technology option is cheaper to operate, environmental friendly and do not require skilled manpower fits to rural setting where microwave and autoclave are not affordable

Source: Jamwal (2004)

Technology selection requires clear thought as each of these technologies have their own merits and demerits (Table 5). Treatment technologies are also influenced by prevalent standards, policies and legislations. As for example, USEPA's stringent pollution control standards and effective enforcement caused the decline in medical waste incinerators and increase in alternative technologies in the United States (Figure 3, Figure 4). One of the reasons for unpopularity of the incinerators is due to the Dioxin emissions. Box 2 presents information on Dioxin.

Table 5: Advantages and disadvantages of different technologies

Treatment technologies	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 in varying size from desktop to industrial • Low investment and operating cost • Ease of operation • Creation of residue that is less hazardous than incineration	• Inability to change waste volume and waste appearance • Lack of suitability for some waste types *e.g. low level radiation, toxic contaminant* • Production of uncharacterized air emissions 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 volume reduction • Ability to make waste unrecognizable and easy to use • Waste deodorization • No combustion by-products	• Possible toxic by-products in wastewater • Lack of suitability for some waste types • Production of uncharacterized air emissions • Need for chemical storage and use

Electron Beam Gun Technology	• Waste volume reduction (20%) • No toxic emissions or discharge (except for small amounts of ozone) • A room temperature process and nothing is added *e.g. steam, water, chemicals, etc* • Well-automated technology and requires little operator time	• High investment cost and operation cost • Shields and safety is necessary to prevent workers from ionizing radiation
Plasma pyrolysis	• Suitable for all types of waste and results in reductions up to 80-90% in volume and in weight	• Suitable for very large hospitals and regional treatment facilities • Still at the demonstration scale

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

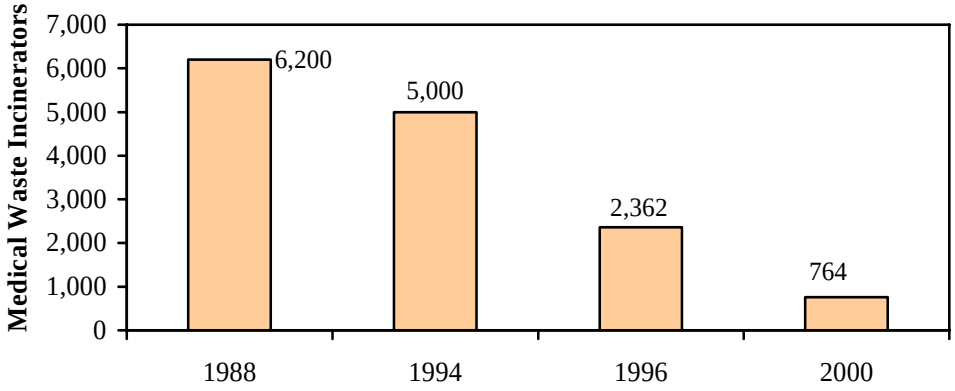

Figure 3: Usage of medical waste incinerators in USA between 1988 and 2000 *(Source: Singh, 2003)*

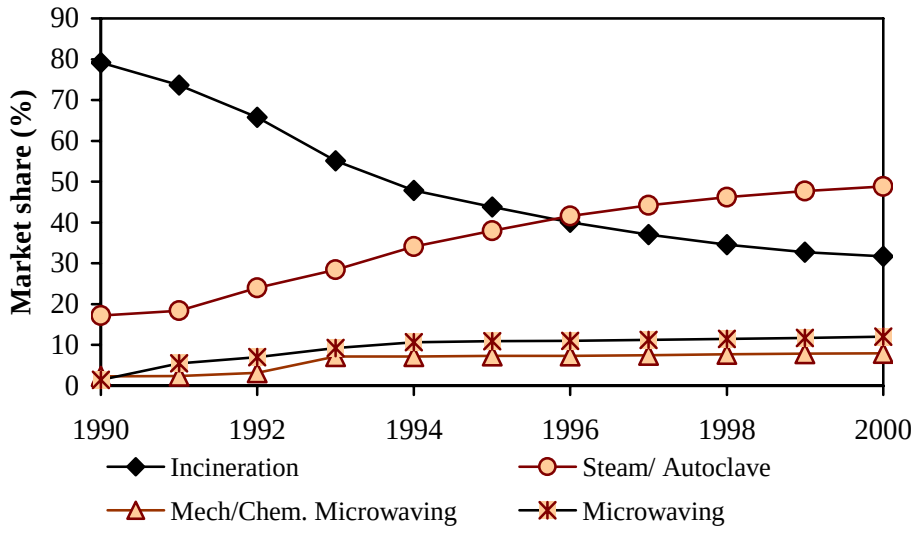

Figure 4: Trends in medical waste disposal technologies in USA *(Source: Agrawal, 1998)*

Box 2: Dioxins - An unseen deadly incineration by-product

- One member of "Dirty Dozen" list of Persistent Organic Pollutants (POPs**)**
- Known carcinogens, linked to birth defects, immune system disorder and other harmful health effects.
- Created when PVC plastic or any other chlorine containing material is burned in the presence of organic matter.
- Increased disposables in medicine leads to increase in plastic going to incineration
- Very expensive to monitor and control: to analyze dioxin in human tissue there are less than 50 laboratories certified by WHO in the world and the cost per sample varies between US$1,000 and US$3,000.
- PVC containing medical products are
  - Colostomy bags, blood bags,
  - Intravenous tubes & syringes
  - Catheters, urine bags,
  - Plasma collection bags
  - Infusion sets ,draw sheets
  - Vinyl gloves, sharp containers

Source: Singh (2003); Health Care Without Harm webpage

4. Healthcare Waste Management in South Asia

Healthcare waste management in South Asia is an impending disaster. Mushrooming clinic and health centers, often unregistered, clearly have created an environmental havoc by disposing the bio-medical waste scattered in and around the establishments attracting flies, insects and rodents, etc. that are responsible for the spread of communicable disease. Waste management, even in government hospitals, is less than satisfactory. Uncontrolled burning, reuse of disposable items, unintentional injuries from improperly discarded sharps, are common and leads to life-threatening infections such as Hepatitis B, Hepatitis C and HIV (World Bank, 2000). The following sections describe the state of healthcare management in South Asia.

4.1 Legislation Governing Healthcare Waste Management

4.1.1 Bangladesh

The Bangladesh Environment Protection Act, 1995 defines pollution as:

"contamination or alteration of the physical, chemical or biological properties of air, water, or soil, including the change in temperature, taste, turbidity, odour or any other characteristics of these or such discharge of any liquid, gaseous, solid and radioactive substance, the discharge, disposal and dumping of which may cause adverse/negative changes of the environment."

There is no specific legislation pertaining directly to the handling, transportation or disposal of medical waste in the Bangladesh Environmental Protection Act (1995). However, wastes are classified under Section 2 (1) as "any liquid, solid and radioactive substance that is discharged, disposed, or dumped which may cause adverse/negative change to the environment".

4.1.2 Bhutan

Currently, there are no separate rules for healthcare waste management in Bhutan; they are handled as part of the Water and Sanitation Rules, 1995. The Water and Sanitation Rules (1995) briefly discusses the guidelines for collection, transportation and disposal of solid waste from different sectors. However, the existing legislation lacks clear categorization of bio-medical waste and hazardous waste (UNEP, 2001a). Applicable rules related to healthcare facilities are presented below:

- Pathogenic and infectious waste shall be collected in a sterilized container or disposable bag and incinerated at the Jigme Dorji Wancghuck National Referral Hospital or treated by decomposition in slaked lime. Incinerated ash and fully decomposed treatment residue shall be disposed off in the same manner as waste from residents.

- Special hospital waste and pharmaceutical waste shall be collected in labeled boxes and disposed off in a manner that prevents accidental contact with collection worker or public. The disposal of these wastes in pubic waste bins or container is prohibited.

4.1.3 India

The Government of India notified the Bio-Medical Waste (Management and Handling) Rules, 1998 making it mandatory for such health facilities liable for segregation, packing, storage, transportation and disposal of wastes. Bio-medical wastes are classified into ten categories (Table 6) and different type of color coded containers assigned for different categories corresponding to the treatment and disposal methods. Incineration, deep burial, autoclaving, microwaving, disinfection and disposal in landfill are among the disposal options (Table 7). The Bio-Medical Waste (Management and Handling) Rules 1998 has been amended twice: the first on 6, March 2000 changed the rules concerning waste management facilities for treatment of waste and the second on 2, June 2000 defined the role of different institutions including the municipal body, Pollution Control Boards/Committees and Authorities (WHO, 2005).

Table 6: Categorization as per bio-medical waste regulation

Category	Type of waste
1. Human anatomical waste	Human tissues, organs, body parts
2. Animal wastes	Animal tissues, organs, body parts, carcasses, fluid, blood; experimental animals used in research, waste generated by veterinary hospitals
3. Microbiology and biotechnology wastes	Waste from laboratory cultures, stocks or specimens of micro-organisms, live or attenuated vaccines, human and animal cell cultures used in research, infectious agents from research and industrial laboratories, from production of biological wastes, toxins, dishes and devices used to transfer of cultures
4. Waste sharps	Needles, syringes, scalpels, blades, glass, etc., capable of causing punctures and cuts. This includes both used and unused sharps
5. Discarded medicines and cytotoxic drugs	Waste comprising outdated, contaminated and discarded drugs and medicines
6. Soiled wastes	Items contaminated with blood fluids including cotton, dressings, soiled plaster casts, linens, bedding
7. Solid wastes	Disposable items other than the waste sharps, such as tubing, catheters, IV sets etc.
8. Liquid wastes	Waste generated from laboratories, washing, cleaning, house-keeping and disinfection activities
9. Incineration ash	Ash from incineration of any medical wastes
10.Chemical wastes	Chemicals used in production of biological, disinfection, insecticides, etc.

Source: The Gazette of India (1998)

Table 7: Segregation, storage and treatment options of biomedical waste in India

Waste category	Type of container	Color code	Treatment options with standards
Human anatomical waste	Plastic bag	Yellow	*Incineration* Temperature of primary chamber: 850±50°C Secondary chamber: 1050±50°C Stack height: 30 m *Deep burial* Pit: 2 m deep Lime cover: 50 cm
Animal wastes			
Microbiology and biotechnology waste			
Soiled wastes			
Microbiology and biotechnology wastes	Disinfected container/	Red	*Autoclaving* 121°C at 15 psi for 60 min.

Soiled wastes (body fluids, cotton, dressings, soiled plaster casts, linens, items, contaminated with blood catheters, intravenous sets, etc.)	plastic bag		135°C at 31 psi for 45 min. 149°C at 52 psi for 30 min *Microwaving Bacillus subtilis* as an indicator in the form of spores using vials or spore strips with at least $1x10^4$ spores per ml
Waste sharps	Plastic bag/ puncture proof container	Blue/white translucent	*Autoclaving* 121°C at 15 psi for 60 min 135°C at 31psi for 45 min. 149°C at 52 psi for 30 min. *Microwaving Bacillus subtilis* as an indicator in the form of spores using vials or spore strips with at least $1x10^4$ spores/ml
Discarded medicines and cytotoxic drugs	Plastic bag	Black	Disposal in secured landfill
Incineration ash			
Chemical wastes			

Source: The Gazette of India (1998)

4.1.4 Maldives

The Environmental Protection and Preservation Act (4/93) enacted in April 1993, established a framework upon which regulations and policies can be developed to protect and preserve the natural environment and resources for the benefit of future generations. Although Clause 7 mentions that disposal of waste, oil and poisonous substances shall be regulated, there are no separate rules related to healthcare waste management.

4.1.5 Nepal

The only legislation directly related to waste management in Nepal is Solid Waste Management and Resource Mobilization Act (1987) which created the Solid Waste Management and Resource Mobilization Centre (SWMRC). Later, the Local Self-Governance Act (1999) transferred the responsibility of waste management to local bodies. The country does not have any program for hazardous waste management. There are no policies and legislations dealing with such waste. The government does not define hazardous waste and any standards for its management is lacking. It is not clear which government agency is responsible for dealing with issues related to hazardous waste (UNEP, 2001 b).

4.1.6 Pakistan

The legislation regarding healthcare waste is covered under Pakistan Environmental Protection Act 1997 and covers disposal and handling of hazardous waste along with National Environmental Quality Standards. Although the National Environmental Quality Standards do not specifically mention about healthcare waste, it highlights that pollution from any such sources entering air, water or land should not exceed the prescribed limits. The Pakistan Environmental Protection Act 1997 has prohibited handling of hazardous substances, which can only be dealt under the license.

Chapter 1, item 2 (xxi) describes the definition of hospital waste as

"waste from medical supplies and materials of all kinds, as well as waste blood tissues, organs and other parts of the human body from hospitals, clinics and laboratories" (UWEP, 1997) .

In response to increased environmental concerns, the Government of Pakistan notified Hospital Waste Management Rules in 2005, defining the different categories of hospital wastes. The rule provides procedures for establishment of waste management systems and describes roles and responsibilities of different personnel working in the hospital including the techniques for segregation, handling, storage, transportation and disposal of hospital waste in a safe manner (Government of Pakistan, 2005).

4.1.7 Sri Lanka

National Environmental Act (NEA) is responsible for environmental protection in Sri Lanka. The National Environmental Act No. 47 of 1980 with its amendments No. 56 of 1988 and No. 53 of 2000 are the basic legal documents that regulate the management of healthcare waste in Sri Lanka. But in reality, these legal instruments are of no use as far as the health sector is concerned due to technical/legal oversight. At present, there is no proper legal framework to regulate it (UNEP, 2001 c).

4.1.8 Summary

In general, most of the South Asian countries lack legislations directly related to healthcare waste management. It is addressed in the national policies in some countries, for example Bhutan and Sri Lanka. The guidelines /policies regarding such waste do not exist in some countries. A summary of legislation, policies and guidelines is presented in Table 8.

4.2 Generation of Healthcare Waste

In order to prepare a well-planned waste management system, it is essential to know the quantity of waste generated as well as the different waste categories in a particular establishment. The quantity of healthcare wastes generated in South Asia largely differs

within countries, primarily due to their economy. An estimate of hospital waste generation in some countries in South Asia is reported in Table 9. Since data on waste quantities are not maintained by all hospitals; the specific waste generation rate is difficult to obtain. Specific waste generation rate per bed in some South Asian countries is presented in Figure 5.

Table 8: Summary of legislation, policy and guideline in South Asian countries

Country	**Legislation**
[1]Bangladesh	No proper legal framework to regulate healthcare waste in National Environment Act, 1995
[2]Bhutan	Guidelines for Infection Control (Ministry of Health) *Healthcare waste management is addressed Environmental Code of Practice for Hazardous Waste Management, 2001 Policy*
[3]India	Biomedical waste Regulations (1998) (1st amendments: March 2000 & 2nd amendments June 2000)
[4]Maldives	No separated rules related to healthcare management in Environmental Protection and Preservation Act 1993
[5]Nepal	No polices and legislation dealing with hazardous waste
[6] Pakistan	Hospital waste management rules, August 2005
[7]Sri Lanka	No proper legal framework to regulate healthcare waste in National Environmental Act. A draft of National policy in HCWM exists in 2001.

[1] Nessa et al. (2001) *[2] Royal Government of Bhutan (2004)*
[3] Government of NCT Delhi, (2002) *[4] UNEP (2002)* *[5] UNEP (2001b)*
[6] Government of Pakistan (2005) *[7] UNEP(2001) c & World Bank (2002)*

Table 9: Generation of Hospital waste in South Asian countries

Country	**Waste generation (Kg/bed/day)**	**Annual waste generation**
Bangladesh	0.8-1.67 [i]	93,0755 tons (255 ton/day) [vii] (only in Dhaka)
Bhutan	0.27 [ii]	73 tons[viii]
India	1.0-2.0 [iii]	0.33 million tons[ix]
Maldives	NA	146 tons* [x]
Nepal	0.5 [iv]	2,018 tons [xi]
Pakistan	1.63-3.69 [v]	0.25 million tons [xii]
Sri Lanka	0.36 [vi]	6,600 tons (only from Colombo) [xiii]

*includes waste oil from electric generator and vehicles

[i]Rahman et al (1999) *[ii,viii] Royal Government of Bhutan (2004)*
[iii]Agrawal (1998) *[iv,xi] MoH (2001)* *[v] UWEP (1997)*
[vi, xiii] Basnayake (2001) *[vii] Akter & Tra¨nkler (2003)*
[ix] Patil & shekdar (2001) *[x] UNEP (2002)*
[xii] Government of Pakistan (2005)

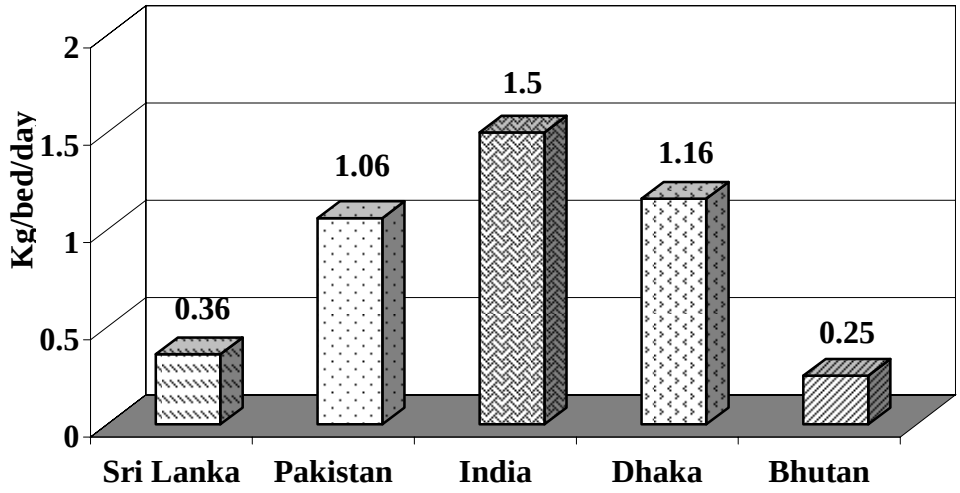

Figure 5: Average hospital waste generation in some South Asian countries

4.2.1 Bangladesh

There are currently 645 public and 288 private sector healthcare establishments in Bangladesh (Akter and Tra¨nkler, 2003). Roughly 20% of total medical waste generated in Dhaka is categorized as infectious/hazardous (Nessa et al., 2001). The average generation is 0.55 -1.10 kg/bed/day, with about 0.17 kg/bed/day of hazardous material. World Bank estimates that about 36,000 tons of healthcare waste is generated every year in Bangladesh. Hospital wastes often get mixed with domestic solid waste. The Bangladesh University of Engineering and Technology (BUET, 1999) conducted a study in some hospitals in Dhaka City and found that an average rate of medical waste generation was 1.0 kg/bed/day. In a separate study by BUET in different hospitals in Dhaka City in 1997, it was found that the rate of waste generation was about 1.16 kg/bed/day, and the hazardous waste was 0.169 kg/bed/day. The contribution of infectious, sharps, and pathological wastes was about 10.5%, 3.5%, and 1.5% respectively.

4.2.2 Bhutan

There are 29 hospitals (including Referral and District) and 160 Basic Health Units (B HU) in Bhutan. While there has been no assessment of waste generated, it has been estimated that 73 tons of infectious waste and sharps are generated annually in Bhutan. From this, approximately 54 tons/year are from the hospitals and the rest from the BHUs (Royal Government of Bhutan, 2004). Estimated infectious waste generation was 0.25 kg/ patient/day and sharps production was 0.02 kg/patient/day. More details on the healthcare facilities and their waste generation are presented in Table 10.

Table 10: Healthcare waste generation in Bhutan (2000)

District	Hospitals (kg/year)		Basic health units (kg/year)	
	Infectious Waste	Sharps	Infectious Waste	Sharps
Thimphu	17,311	1,385	624	13
Paro	1,676	134	312	8
Punakha	1,421	114	520	13
Ha	913	73	624	13
Gasa	0	0	312	8
Wangdue Phodrang	577	46	1,040	23
Chhukha	2,750	220	936	23
Samtse	3,068	245	1,248	31
Zhemgang	1,849	148	1,560	36
Dagana	0	0	936	21
Tsirang	624	50	624	16
Sarpang	2,552	204	1,456	34
Trongsa	603	48	520	13
Bumthang	605	48	312	8
Mongar	5,193	415	1,768	44
Lhuntse	768	61	1,040	26
Pemagatshel	1,145	92	416	10
Yangtse	830	66	312	8
Trashigang	4,297	344	1,976	49
Samdrup Jongkhar	4,257	341	1,768	39
Total	50,435	4,035	18,304	437

Source: Royal Government of Bhutan (2004)

4.2.3 India

The country's urbanization growth has brought the rapid establishment of medical facilities in urban centers than in rural areas. Waste management systems in the urban areas are already overburdened. The specific system ensuring separation of infectious and non-infectious waste at source is necessary for efficient management of healthcare waste.

At present, separate systems for disposal of such type of waste are available in only a few establishments. Reckless disposal of infectious wastes with municipal waste further aggravates the problem.

In Delhi alone there are 620 hospitals with 32,000 beds and 893 dispensaries. This number may be lower as more hospitals and nursing homes have been registered in the recent years (Government of National Capital Territory of Delhi, 2002).

The quantity of waste generated varies between hospitals and depends on the type of the facility and local economic conditions. The quantity of medical waste generated in Bangalore alone is more than 9.22 ton/day (Table 11). For the entire country, the annual estimate is 0.33 million tons. The composition of the waste shows (30-35%) infectious waste, (7–10%) plastics, (0.3-0.5%) disposable syringes, (3-5%) glass and (40–45%)

general wastes including food (Patil and Shekdar, 2001). A survey found the proportion of solid waste generated as given in Table 12 in various hospitals of Indore. The quantity varies widely depending upon the estimation method and nature of healthcare establishments. An approximate estimate of 1 to 2 kg of waste/bed/day has been reported by Agrawal (Agrawal, 1998). The specific waste generation in Mumbai is presented in Table 13.

Table 11: Quantity of waste generated in Bangalore

Type of Institution	No of Beds		Quantity of Waste generated in Kg/day
	Government	Private	
Major Hospitals (> 500 beds)	2,486	5,047	3,766
Major Hospitals (200 to 499 beds)	2,599	2,269	2,434
Less than 200 beds	3,084	2,765	2,924
Non-bedded healthcare establishments (clinics, Laboratories, blood banks, dispensaries, medical centers)	0	0	100
Total	8,169	10,081	9,224

Source : The Energy Resources Institute, Bangalore

Table 12: Proportion of different solid waste in Indore city

Type of waste	Average (%)
General	71.37
Infectious	18.83
Pathological	8.11
Chemical	0.91
Sharps	0.78

Source: Patil & Shekdar (2000)

Table 13: Total waste generated per patient in Mumbai

Hospital	Total waste (per kg/patient/day)
Private (20 beds)	0.25
Private (21-50 beds)	0.19
Private (> 50 beds)	0.98
Municipal	1.08
Government	0.7

Source: Agrawal (1998)

4.2.4 Maldives

A study conducted in 1998, shows that 0.4 tons of hazardous waste is generated in Male and this includes clinical waste and oil from electric generator and vehicles (UNEP, 2002).

4.2.5 Nepal

With the growth of country's urban population, there has been a significant expansion of healthcare facilities. This resulted in a sharp rise of hazardous solid wastes generation. Environment and Public Health Organization (ENPHO) estimated that there are 2,347 beds in government hospitals and 1,558 beds in private hospitals and nursing homes, which generate about one ton of infectious waste per day. Most of the medical waste is discarded along with the municipal waste and only a small proportion of it is burned in healthcare institutions which have incinerators and autoclave treatment facilities (UNEP, 200 b). Hospitals and nursing homes in the Kathmandu valley alone produce over 250 kg of hazardous medical wastes each day (The Rising Nepal, 2005). Total amount of healthcare waste generation estimated by Ministry of Health is presented in Table 14.

Table 14. Estimated total amounts of healthcare waste generated in Nepal (2001)

Healthcare facility types	**Kg/day**
Small HCFs, *	456
Health Posts, ** Sub Health Post, ** & Outreach Clinics ***	1910
Medium HCFs **	1130
Large HCFs **	2034
Total	**5 530**

* For HCF with beds: 0.5 kg/patient/day

** For Health Post and Sub Health Post: 0.5 kg/HCF/day

*** For Outreach clinics: 0.1 kg/HCF/day.

Source: MoH (2003)

4.2.6 Pakistan

In Pakistan, around 250,000 tons of medical waste is annually produced from all sorts of healthcare facilities (State of Environment Report, 2005, Government of Pakistan). A study conducted by Scott and Purphy and NESPAK (1997) has revealed that waste from government hospitals in Karachi varies between 1.63 kg/bed/day and 3.69 kg/bed/day with an average of 3.02 kg/bed/day. The generation rate at private hospitals in Karachi was assessed to be 5.13 kg/bed/day. Based on these results the total hospital waste generation from in Karachi is assessed to be 100 tons/day. Table 15 shows the quantities and composition of hospital waste generated in different cities in Pakistan.

Table 15: Hospital waste generation in different cities of Pakistan

City	No. of hospitals surveyed	Total No. of beds	Generation Rate in Kg/bed/day
Karachi	5	3,500	1.20
Lahore	6	4,188	1.05
Rawalpindi	9	1,552	0.99
Multan	4	1,235	1.46
Faisalabad	9	1,546	1.00
Gujranwala	9	1,037	098
Sargoda	6	435	0.71
Total	48	13,493	1.06 (average)

Source: UWEP (1997)

4.2.6 Sri Lanka

There have been several hazardous waste surveys conducted by different institutions: Central Environment Authority (CEA) Hazardous Substances Survey (1988), Pre-Feasibility Study on Hazardous Waste Management and Disposal for Sri Lanka; and Environment Resource Management (1997). Latest Environment Resource Management (1997) study estimates that waste generation from registered government healthcare system is 6,600 tons per annum. This assumes an average waste generation of 0.36 kg/bed/day for a registered 50,091 beds. Waste generation from small private clinics is excluded in this estimation. The generation of clinical waste in different government hospital in Colombo is presented in Table 16.

Table 16: Generation of Clinical Waste in Colombo

Government Hospital	Registered Number of Beds/Cots	Estimated clinical waste (kg per day)		
		General Clinical Waste	Sharps	Total
		(0.33 kg/bed/day)	(0.03kg/bed/day)	(0.36 kg/bed/day)
Army		179	16	195
Ayurveddic	306	101	9	110
Cancer Institute	634	209	19	228
Castle Street	396	131	12	143
Colombo North	1067	352	32	384
Colombo South	668	220	20	240
De Soysa	423	104	13	153
Dental Institute	42	14	1	15
Eye	471	155	14	169
Fever	90	30	3	33
National	2722	898	82	980
Police	130	43	4	47
Sri Lanka Air Force	56	18	2	20

Source: Basnayake (2001)

5. Prevailing Healthcare Waste Management Practices

Healthcare waste is recklessly disposed into the municipal solid waste landfill or open dumpsite in most Asian countries (Figure 6 and 7). In a country like India, incineration technologies are still being propagated despite their potential risk of releasing dioxins (Singh, 2003). Regulations and standards are on the early stage of development and implementation and enforcement of rules are still underway. In general, people are unaware of the risk posed by medical waste. There is an urgent need to establish clear protocols for safe and secure collection, treatment and disposal of sharps to minimize the risks associated with disease transmission.

Figure 6: Spoiled medicine capsule dumped together with municipal solid waste in dumpsite (Nonthaburi, Thailand)

Figure 7: Infectious waste in red plastic bag is co-disposed with municipal solid waste

5.1 Bangladesh

An estimated 255 tons of medical waste is generated in Dhaka every day. Most of which is dumped in municipal bins (Rahman and Ali, 2000).Only a few hospitals have onsite management systems such as burning, burial, autoclave and/or waste segregation. Some medical colleges and tertiary government hospitals have incinerators on site. Even though no alternative method is prescribed, the Department of Environment does not permit the operation of incinerators due to environmental concern. Some private institutions and NGOs operate their own incinerators for infectious waste. A few hospitals store waste in their net houses or closed dustbins before sending to the city corporation bins. Generally, solid wastes, saline bags, and non-sharps are disposed off in improper way. An overwhelming number of the waste pickers in Bangladesh sort these waste and sell all that can be recycled. The waste pickers adopt no protective clothing, exposing themselves to injury and sickness. Moreover, the municipal dustbins of Dhaka, where the hospitals place their waste are left exposed to the environment for days before collection (Akter et al., 1999). A study conducted by Akter and Tra¨nkler (2003) revealed that apart from separating syringes/needles, hospitals do not practice waste segregation before disposal. Problems of proper managements were:

- No specific institute responsible for Medical Waste Management (MWM).
- Lack of cooperation within and among various agencies is a pertinent problem.
- Few local initiatives have been undertaken by some NGOs. Lack of awareness of potential risks.
- Hospital authorities tend to overlook health issues as it involves large sums of money.
- Lack of in-house management. Selected items like saline bags and containers are recycled centrally in some hospitals.
- Unauthorized medical waste segregation, recycling and reuse is often conducted in and outside hospitals by informal sectors.

5.2 Bhutan

The National Environment Commission (NEC) passed an Environmental Assessment Act in July 2000 and issued a number of guidelines to support the Act. Handling of solid waste is addressed in 'Environmental Codes of Practice for Solid Waste Management in Urban Areas' prepared in October 2000 and in the 'Environmental Code of Practice for Hazardous Waste Management' issued in November 2001. Royal Government of Bhutan with the cooperation and support of DANIDA, is in the process of developing a National Infection Control and Healthcare Waste Management Programme.

5.3 India

In 1997, the Supreme Court passed a rule for the installation of incinerators in all hospitals with bed strengths above 50. After Srist's (an NGO) intervention, the court directed the Central Pollution Control Board (CPCB) to allow for non-dioxin creating technologies such as waste autoclaves and microwaves and make standards for such technologies. In a survey performed during May 1997 by Sristhi**,** 82% of the incinerators were burning mixed waste and 80% of the incinerators were not maintaining the temperature norms. The temperature was found optimum for dioxins and furans formation (190-400^{o}C).The incineration industry worldwide has proven itself to be phenomenally unpopular being the highest source of dioxin releaser. Level of dioxin in Delhi based on Sristi's report is presented in Box 3.

Box 3: Dioxins in Delhi

- In a recent study, dioxin was measured in tissues of humans, fishes, chickens, lambs, goats, predatory birds and Ganges River dolphins, collected from various locations in India
- Concentrations of dioxins were found in most of the samples analyzed, the liver of the spotted owlet containing the highest concentration of 3,300-picogram/gram fat weight while in the human fat tissues they existed in concentrations ranging from 170 to 1300 picogram/g ram fat weight.
- As compared to WHO limits of 1-4 picogram/kg of body weight, this contamination levels is seriously alarming.

Source: Singh (2003)

In consideration of the Rules and Guidelines for Biomedical Waste Management and their implementation, an audit was done by Controller and Auditor General (CAG) in Delhi (Government of National Capital Territory of Delhi, 2002). This study reveled that the present status of implementation of these rules is far from satisfactory and the objectives have scarcely been achieved. Some findings are:

- 27 out of 44 hospitals failed to ensure proper segregation, treatment and disposal of Bio Medical Waste.
- Some hospitals including All India Institute of Medical Sciences did not comply with the instructions regarding labeling of bags containing bio-medical waste**.**
- Hospital authorities did not take sufficient measures to create public awareness in Bio Medical Waste Management implementation programme.
- Hospitals used the same wheelbarrow for transportation of all categories of waste to the disposal points.
- Bio Medical Waste was not lifted in time and was retained at generation point beyond 48 hours of its generation. Incineration facilities were under utilized and temperature of incinerator not maintained as per CPCB norms.
- In one of the hospital in the absence of proper fencing of incineration plant the rag pickers were seen shifting the Bio Medical Waste with bare hands, exposing

themselves to health hazards. Besides, used syringes, needles intravenous sets etc, were recycled and resold as observed in some hospitals**.**

- Intravenous sets, tubes, catheters, plastic bags, syringes, gloves etc. required to be autoclaved were incinerated causing pollution problem.

- Personal protective equipment was not provided to health workers or to those working at incinerators and autoclaves.

5.4 Nepal

As mentioned earlier, there are no state level policies regarding the management of hazardous waste to check and monitor its disposal. Haphazard disposal of medical waste has been a threat to public health and a source of environmental pollution for Kathmandu Metropolitan City (KMC). A wide range of institutions such as municipalities, Ministry of Health, Ministry of Environment are involved in this sector but their responsibilities of for managing such waste is not clear. At present in most municipalities, hazardous waste is dumped along with municipal waste causing a major public health risk. Few of the individual healthcare institutions have set treatment facilities such as incinerators and autoclave to treat its waste, mainly under foreign assistance. There are no guidelines imposed for the establishment of waste incinerators in the country. The operated working temperature in incinerators was below the desired value. According to researches conducted by some independent experts, though some hospitals in Kathmandu are using incineration to manage waste, a number of nursing homes in core areas of Kathmandu valley are generating medical wastes causing a dire impact on public health.

More than 90% of healthcare institutions do not practice safe waste handling, storage and disposal methods and most healthcare institutions rely on municipal services for their ultimate disposal. In Kathmandu Valley, Tribhuvan University Teaching Hospital and Patan Hospital have incinerators to treat their wastes. Other hospitals and health facilities, however, rely on containers provided by Kathmandu Municipality. Bir Hospital, the country's oldest hospital, has been in a peculiar position ever since local residents destroyed its incinerator a few years ago. Teku Hospital treats patients affected by all kinds of infectious diseases, including HIV/AIDS, Hepatitis B, C and cholera, the absence of incinerators forces it to dump infectious waste in normal containers, threatening the health of local residents (Poudel, 2002).

According to the study conducted by Save the Environment Foundation (SEF), hospitals collect all medical wastes including pathological wastes, syringes, bandages and others in a normal bin and dump into the municipal containers. Personnel who handle those wastes do not use even gloves while dumping the material. In the absence of legislation mandating the safe disposal of medical wastes, the authorities are unable to regulate the activities of health institutions.

5.5 Pakistan

A survey reveals that none of the government hospital has proper arrangements for waste disposal and there is also concern that costly apparatus meant to be used once is sometimes reused. Much of the waste is plastic, such as tubes and syringes that are picked up by rubbish scavengers from solid waste dumping sites and sold on. Sanitary staffs of hospitals are involved in selling disposable waste to various parties for recycling. The buyers send the waste for re-packing and recycling. Drug addicts often reuse the disposable syringes lying in rubbish drums. Besides, the birds, animals and insects can transfer infections from waste to human bodies.

According to a study an average Pakistani uses five disposable syringes per year, making a demand of about 750 million syringes. It says Pakistan imports over 250 million syringes and 500 million syringes are produced locally in suspicious conditions. Most of these 500 million disposable syringes are often used in rural areas (Pakistan Press International, 2006).

The hospital waste management practices are not same in all hospitals. Some hospitals are trying to manage their waste in proper way. Aga Khan University Hospital is one such example (Box 4).

Box 4: A good practice: Aga Khan University Hospital, Pakistan

- More than 2,500 in- and out patients a month
- Waste handling is the responsibility of the Housekeeping Section of the Maintenance Department with 210 housekeeping staffs and 13 managers
- All new personnel must attend a 15-20 day training course prior to starting work. House keepers and incinerator operatives are required to wear a uniform, including protective gloves and a face mask.
- The waste is separated at the point of generation into different coloured bags
    - Infectious, pharmaceutical and chemical waste➔ double red bags;
    - General solid waste ➔ green bags;
    - Kitchen waste ➔ blue bags;
    - Disposable surgical items such as used syringes, sharps etc. ➔ puncture proof containers marked 'danger'
- Green and blue bags are carried to a storage site where the recyclable material (e.g. paper, plastics) is separated and sold to private contractors.
- Kitchen waste (e.g. organic waste) is ground and disposed of in the municipal sewer system. The remaining waste transported by the Karachi Metropolitan Corporation to the municipal landfill site.
- Human waste, such as blood and urine, from treatment rooms and wards is disinfected before sending to the municipal sewers Liquid waste such as blood and urine from the laboratories is flushed into the municipal sewers via underground neutralizing tanks containing calcium carbonate and other disinfectants. Chemical waste is first de-activated within research laboratories before going through the neutralizing tanks
- The red bags are placed in closed containers and when full, the containers are wheeled to the incinerator located on the hospital premises; residual ash is transported by a private contractor to the municipal landfill site.

Source: Appleton and Ali (2000)

6. Efforts on improvement of healthcare waste management

6.1 Improved legislation, guidelines and policies

To address the mounting health and environmental concerns, South Asian countries are giving greater attention to improve legislation and guidelines related to healthcare waste management. As for example, India notified Bio-Medical waste management Rules in 1998 and two amendments came in 2000. Similarly, Pakistan also notified Hospital Waste management rules in 2005. A draft version of National policy (2001) on healthcare waste managements exists in Sri Lanka. As well as in Bhutan, infection control policy has been established under the 'Guidelines for Infection Control in Healthcare Settings' developed by the Ministry of Health. Healthcare waste Management Policy is addressed in 'Environmental Code of Practice for Hazardous Waste Management' issued in November 2001. Efforts to manage hospital waste are continued in Bangladesh also. A committee of the Department of Environment (DoE) suggested guidelines titled Bio-Medical Waste Management and Process Guideline/Rules (2000.2001). This was put forward to identify environmentally friendly techniques for hospital waste management in Dhaka. The Directorate General of Health Service under the Ministry of Health and Family Welfare has published a manual for Medical Waste Management in 2001. Similarly, Nepal Health Research Council in cooperation with WHO prepared and published "National Health Care Waste Management Guidelines" and "Training Manual for Medical Professionals" addressing healthcare waste management and related issues.

6.2 Moving towards better technology

Incinerators which were thought to be the best method of eliminating infectious organisms in the past are now considered environmentally unpopular because of toxic pollutant emission. Governments in the region are beginning to realize that only investing in the incinerators cannot solve the medical waste problem. Department of Environment, Dhaka City Corporation, as for example, has realized the environmental concern due to incineration and does not permit the operation although alternative methods are not prescribed. Recently, in India, installation of the individual incinerators is also discouraged and healthcare units are urged to treat their waste in Common Bio-medical Waste Treatment Facilities (CBWTF). Acknowledging economic and environment ramifications many private hospitals decided to shut down incinerators and looking for non-burn technologies (Perappadan, 2004).

World Health Organization and United Nations Development Program together with Healthcare Without Harm are taking initiative to reduce environmental release of dioxin and mercury by promoting best practices and techniques. The project funded by Global Environmental Facility is to be impended in seven participating country in which India is also included.

6.3 Role of NGO's and other activates

NGOs and communities are playing increasingly vital roles in medical waste management in South Asia. An example of successful operation of healthcare wastes management by an NGO (Prodipan) is found in Khulna city, Bangladesh as presented in Box No 5. An NGO named Sristi, in India, played a key role in discouraging incineration technology, pushed for court intervention successfully to direct Central Pollution Control Board to emphasize on non-burn technology**.** Also in India, Centre for Environmental Education (CEE) developed and implemented an Integrated Healthcare Waste Management Plan and implemented in few hospitals in Delhi through training and awareness program. With the support from WHO, CEE also developed a national kit on biomedical waste management to educate people (The Hindu, 2004). Similarly, Save the Environment Foundation (SEF) an NGO under the Colorado Nepal Environmental Exchange Program has played significant role in highlighting the consequences of Nepal's current practice of disposing of hazardous medical wastes and drawing the attention to government.

Box 5: Hospital waste management programme in Bangladesh (public-private partnership)

- ➔The Water and Sanitation Program (WSP) of the World Bank, with the support of Swiss Agency for Development and Cooperation (SDC), launched a community-based solid waste management project in Khulna 2000.The project was locally implemented by Prodipan, a national NGO, with participation of 20 private hospitals and pathological laboratories.
- ➔Khulna Hospital Waste Management includes Training Programme in segregating the waste into: *Syringe, saline bag and other plastics*; *Gauze, bandages, human organs; paper materials and others*; *Kitchen waste*
- ➔ Collection staff of the Programme collects and transport by specially designed vehicle.
- ➔ All sharps (e.g. needles, blades) and plastics are placed in a concrete pit with a lockable lid. All bandages, gauze, cotton, body parts, and paper are burned in a locally-made incinerator.
- ➔ Plastic items such as syringes and intravenous bags are disinfected by immersing in chlorine solution. Then they are destroyed by a shredder machine to prevent reuse.
- ➔ There is a shallow concrete lined pit with a tin shed for temporary storage of non-plastic infectious items such as bandages, cotton.
- ➔ Each of participating institutions is paying a monthly service charge between Tk. 100 and Tk. 600 (US$ 1.5 to 9) depending on the volume of waste generated.
- ➔ At present there is no external support charges that are being collected are sufficient to cover the running costs. There is a need for introducing improved technology such as autoclaving for sterilizing infected plastic items, which may then be safely shredded and disposed. This will greatly reduce the risk of infection

Source: Ahmed et al. (2006)

6.4 Role of 3Rs

The environment, in general, has become an issue of global concern in recent years. Waste management and recycling measures in general and 3Rs initiative in particular,

have come into international focus for sustainable development. One of such initiatives is G8 '3R'Action Plan and Progress on Implementation (2004). The most important challenge in 3R is the reduction in waste generation and environmentally sound waste disposal and treatment.

Prevailing practices in healthcare have become an important source of environmental pollution and potential harm to health. Heavy metals such as mercury, pathogens, and endocrine disrupters, are present in many healthcare products. In this connection, no opportunity should be left to apply the principle of 3Rs (reduce, reuse and recycle) in hospital waste management. Out of 3Rs, source reduction has higher potential to be implemented in hospital waste management. Source reduction as the key component lies at the top of the hierarchy in the integrated solid waste management. It reduces the amount of materials produced and the harmful environmental effects associated with it. This proactive approach offers several benefits such as resources conservation, avoided waste collection, transportation, and disposal costs, decreased pollution control, liability, and regulatory compliance costs, reduced product and material use and disposal costs. Some of the potential source reduction practices are given below:

- Segregation: waste segregation can drastically reduce the volume and toxicity of the waste stream. The volume of the infected waste can be reduced after proper segregation and significant cost can be saved for its treatment.

- Material/device substitution: Proper procurement practices for example changing the products and materials can help to reduce the harm. There are some viable substitutes for many products that contain PVC plastic, mercury etc. For example mercury based thermometer can be substituted by electronic sensing devices

- Segregation of medical products containing PVC. Dioxin production through incineration can be avoided by not allowing such items to go to incinerators.

- Use first-in and first-out policy in dispensing drugs and chemicals

- Increasing awareness of hospital staff and management employee training in hazardous materials management and waste minimization.

7. Conclusions and Recommendations

The major fraction (75-90%) of the waste generated by health-care facilities are, in general, non-risk wastes and resembles residential and institutional wastes. The remaining fraction (10-25%) is hazardous (risk) and may pose a variety of health risks. Therefore there is a need to promote the concept of "source separation" as a priority action.

The volume of the waste generated in some of the countries (Bhutan, Maldives) is too small to have an economically viable treatment plants. Thus, a regional approach could be developed in terms of waste color coding, trans-boundary movement of these wastes

for treatment. In terms of treatment technology, there is a need to promote non-incineration based technologies. However a detailed technical review and a potential technology development need to be done. Few demonstration projects should be setup, at the earliest, to develop a local know-how on these technologies. Greater care should be taken in terms of the radioactive waste generated from this sector; Radioactive waste generated, though low in quantity, can cause high impacts.

Hospitals should be directly responsible for their own waste management like an industry. However, an appropriate national strategy should be developed to handle the large number of "clinic" wastes. Subsidies are not a recommended option for the healthcare waste management. However, a viable financial mechanism should be developed for the small and medium scale clinics.

At the moment, neither the medical staffs nor the administrators pay adequate attention to hazardous waste management and waste minimization. As a priority, this culture needs to be changed, and these two stake holders should play a very important role in this sector of waste management. Frequently both waste pickers and common people should be informed about the need for proper management of healthcare waste. They could be educated to inform the concerned authorities to report potential illegal disposals. Greater budget should be allocated to implement awareness and training program for hospital waste management. Provisions for fines for violators and economic incentives for good practices should be developed.

There is a trend of medical treatment beyond the national boundary, e.g. people from Europe, USA and South-Asia visit India for treatment. This issue should be given due consideration and economic analysis of such treatments should be done.

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Abbreviations

AIDS	- Acquired Immuno Deficiency Syndrome
BUET	- Bangladesh University of Engineering and Technology
BHU	- Basic Health Unit
CAG	- Controller and Auditor General
CBWTF	-Common Biomedical Waste Treatment Facilities
CEA	- Central Environmental Authority
CEE	-Centre for Environmental Education
CPCB	- Central Pollution Control Board
DANIDA	- Danish International Development Agency
DoE	- Department of Environment
ENPHO	- Environment and Public Health Organization
ERM	- Environment Resource Management
HIV	- Human Immunodeficiency Virus
HCWM	- Health Care Waste Management
IV	- Intra Venus
KMC	- Kathmandu Metropolitan City
MWM	- Municipal Waste Management
NEA	- National Environmental Act
NEC	- National Environment Commission
NCT	-National Capital Territory
PEPO	- Pakistan Environmental Protection Ordinance
RGOB	- Royal Government Of Bhutan
SEF	- Save the Environment Foundation

SWMRC - Solid Waste Management and Resource Mobilization

USEPA - United States Environmental Protection Agency

WHO - World Health Organization