Safe Management of Bio-medical Sharps Waste in India

A Report on Alternative Treatment and Non-Burn Disposal Practices
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World Health Organization
Regional Office for South-East Asia
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Abbreviations used
AD: Auto Disable
AIDS: Acquired Immune Deficiency Syndrome
ANM: Auxiliary Nurse Midwife
BMW: Bio-medical Wastes
CPCB: Central Pollution Control Board
MOEF: Ministry of Environment and Forests
PHC: Primary Health center
Deep gratitude and appreciation is extended to the members and experts who contributed to this WHO initiative supported by the SEARO Departments of Immunization & Vaccine Development and of Sustainable Development and Healthy Environments. Special thanks to the members of the NGO’s “SH RISTI” and “Health Care Without Harm”, for completing this work. Special thanks to the Investigation Team: Dr Megha K Rathis, Ms Ratna Singh and Mr Ravi Agrawal. The decisive cooperation extended by all the health care facilities and institutions covered in this study is gratefully acknowledged. This study would not have been possible without inputs from the following hospitals in New Delhi: St Stephen’s, Ganga Ram, Holy Family, Ram Manohar Lohia and Lion’s Hospital. Sincere thanks go to Citizen, Consumer and Civic Action Group, Chennai, Jyotsna Chauhan Associates, Hyderabad, the Community Medicine Department of Ramaiah Medical College, Bangalore, Dr. Alok Ghosh of West Bengal Health Systems and the Mumbai Medical Waste Action Group, for providing information on the status of medical waste in their respective regions. A special vote of thanks to members of the material recovery industry Narela and Wazirpur, Delhi, Individual waste pickers and waste contractors of the various hospitals for having spared their time sharing views on their experiences in reprocessing of syringes of various types. SH RISTI and Voarisoa Observatoire are thanked for the use of their photographs.
The improper management of wastes generated in health care facilities can severely affect the health of caregivers, patients and individual members of the community. It also has the adverse impacts on the environment. In addition, pollution from inadequate treatment of waste can indirectly affect the health of the community.

Throughout the world, an estimated 16 billion injections are administered annually. Needles and syringes that are not disposed of properly pose a grave hazard to public health due to the risk of injury and infection and of the opportunities for re-use.

Worldwide, 8-16 million hepatitis B, 2.3 - 4.7 million hepatitis C and 80 000 - 160 000 HIV infections are estimated to occur yearly from re-used unsterilised syringes and needles. The re-use of disposable syringes and needles for injections is particularly common in certain developing countries.

Additional health hazards occur from scavenging on waste disposal sites and manual sorting of the waste at health-care facilities. These practices are common in many regions of the world. The waste handlers are at immediate risk of needle-stick injuries and other exposures to toxic or infectious materials.

The safe disposal of used needles and syringes and other infectious sharps should therefore be seen as a critical component of any health care waste management programme, if infection is to be prevented.

Where possible, the management of wastes from immunization activities should be integrated into existing health care waste management systems. Furthermore, it is essential that health care waste management is accepted as an integral part of health care by all those concerned.

Auto-disable syringes virtually eliminate the risk of patient-to-patient transmission of infectious diseases with blood borne pathogens (such as hepatitis B, C and HIV) because they cannot be re-used. Their increasing use in immunization services worldwide is extremely encouraging.

Despite the significant advantages of using single-use syringes, their disposal, in a safe, cost-effective and environmentally-friendly manner, particularly in the context of mass immunization campaigns, poses a significant challenge. While a number of solutions exist, it is important that countries establish a Health Care Waste Management system appropriate to local circumstances.
Bio-medical waste whether generated at small primary health centres, rural clinics or in larger facilities, can be managed where adequate well-operated infrastructures exist. However, where resources are limited, small-scale incinerators are being used as an interim solution in less developed and transitional countries. These incinerators often operate at low temperatures and this may lead to the emission of highly toxic pollutants such as dioxins and furans.

The absence of proper waste management, lack of awareness about the health hazards from bio-medical wastes, insufficient financial and human resources and poor control of waste disposal are the most common problems connected with health-care wastes.

In view of the various health risks posed by ill-managed health care wastes, especially sharps, WHO has prepared and issued a new policy paper indicating the Organisation’s strategy in the immediate, the mid- and long-term to boost the reduction of burden of disease attributable to infectious wastes. A copy of the Policy paper is attached to this report.

Though Government commitment and support is needed for long-term improvement of the situation, although immediate action can be taken locally. In the South-East Asia region only five Member States have policy guidelines on Health Care Waste Management and only two have enacted specific legislations.

Because inadequate waste management drastically reduces the overall benefits of health care, there has been an increasing demand for WHO to take an active role in promoting safe health-care waste management. I hope that this report documenting thirteen success stories from India, will help in addressing this challenge.

I am confident that the commitment of health policy makers the Member States in the South-East Asia region, active participation of the experts from key health institutions and the technical support of WHO, we will be able to overcome the current bottlenecks and develop sustainable strategies for the safe management of medical sharps waste.

Samlee Plianbangchang, M.D., Dr.P.H.
Regional Director
Sharps are one of the most hazardous categories of waste generated in health care facilities. Injections are responsible for the generation of the largest quantity of infectious sharps generated during both immunization and curative practices. Due to the risks associated with sharps it is very important to manage them properly and to ensure they remain safe to the health care workers and the community at large.

The present study documents successful sharps management systems in urban areas and evaluates non-burn treatment and disposal technologies. The study evaluated the coherence of these technologies with the current regulatory health care waste management (HCWM) framework in India. Due to the nation-wide introduction of Auto Disable (AD) syringes for immunization programmes, the study also analyses the implications linked to their use and the possibilities of material recovery of these syringes.

The findings of the study indicate that it is of paramount importance to contain the infectious sharps in puncture resistant containers, disinfect and mutilate them at point of generation to ensure the safety of the health care workers and the community at large. The use of alternative treatment and disposal technologies covered in the 13 success stories include needle cutters, chemical disinfection, autoclaving, microwaving, advanced autoclave like Hydroclave™, cement encapsulation and sharps pit. The health care institutions were satisfied with the technologies and felt that mutilation after disinfection was the most effective technique to ensure that infectious sharps are not re-used.

Currently, the methods used for final disposal of sharps were not found to be sustainable. The health care workers felt that it was important to look into the option of material recovery from the injection units.

The concept of AD syringes was new to many health care workers they felt that AD syringes would be very useful during immunization programmes, as it would make sure that the sharps are not re-used. However, the health care workers felt that more research needs to be carried out in identifying the treatment and sustainable final disposal options of AD syringes before these are introduced throughout the country.

Recommendations for the future in the field of sharps management are also presented.
1.1 Overview

Health care activities like immunization, diagnostic tests, medical treatments and laboratory examinations protect and restore health and save lives. At the same time, however, health services may generate large quantity of wastes and by-products that need to be handled safely and disposed of properly. Public concern about medical waste dates back to early 1980’s when large quantities of syringes and needles were found on the beaches of the East Coast and in Florida, USA. The public hue and cry due to a scare regarding the spread of infectious diseases from this waste led to the first legislation on bio-medical waste management in the USA. Later, other countries adopted similar legislation to manage their bio-medical waste effectively.

In India, the concern for medical waste has come to the fore in recent years. The Government of India notified the national Bio-Medical Waste Regulations in July 1998. All the health care facilities in the country are covered under these rules, making it mandatory for such health facilities to manage their waste. Though the rules are being implemented partially, re-use and recycling of bio-medical waste is practiced illegally as it promises lucrative returns. There is also a generalized lack of awareness about the problems associated with bio-medical waste.

From the total quantity of waste generated by health care activities, almost 80% is general waste, comparable to domestic waste. The balance 20% of the waste is considered hazardous and/or infectious. If segregation does not take place, all the waste produced should be considered as infectious, as it is mixed. Different kinds of wastes like blades, lancets, glass, injection units etc. are generated in the health care institutions and injection units (syringes and needles) comprise the most common category of sharps waste. It is for this reason that the UN Convention overseeing the transboundary movement of hazardous wastes (Basel Convention), categorizes medical wastes as the most dangerous of all wastes.
1.2 Current practices in handling sharps

Each year, an estimated 16 billion\(^1\) injections, both preventive as well as curative, are administered worldwide.\(^1\) This amounts to almost 44 million injections per day\(^2\) out of which 95% are therapeutic in nature. For 20 therapeutic injections given, one vaccination is administered. Injections are prescribed for a wide variety of reasons. Injections are certainly essential to administer vaccines and for many types of treatment, but many injections are also given for questionable reasons. An immediate action to reduce the amount of sharps wastes is to reduce the number of unnecessary injections.

Unsafe injections are reported to have the potency of transmitting infections from patient to patient, patient to health workers and, more rarely, from health workers to patients and to the community at large. Sharps from immunization injections are found to be unsafe with almost 30% of the sharps being either re-used or recycled as documented by WHO (WHO Bulletin, October 1999\(^2\)).

Realizing the problems associated with re-usables, and to ensure safety in immunization programmes, WHO, UNICEF and UNFPA issued a joint statement in 1999 on the need for use of auto-disable (AD) syringes and safety boxes to contain them in immunization campaigns\(^3\). The joint statement urged that by the end of 2003, all countries should use only auto-disable syringes for immunizations. Working towards that goal, all partners decided to finance not only the vaccine but also safe administration devices and disposal units and support related training, supervision and sensitization activities to ensure safe vaccinations.

The major challenge associated with the use of AD syringes is the volume of waste that will be generated in the process, and its management.

The absence of a sound health care waste management system, the risks linked to re-use of waste sharps from immunization waste and the environmental impact of improper disposal are major concerns. There is thus an urgent need to find solutions.

The growing use of non AD disposable syringes increases the quantity of waste generated in the rural settings and, due to their lucrative resale value in the market, the problem is magnified. With India’s growing urbanization, rural settings are becoming semi-urbanized and would soon encounter the problem faced in urban areas. The focus of the present study, accordingly, is to find solutions for urban areas.

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1. http://www.who.int/immunization_safety/safe_injections/en/, consulted on 15.05.2005
1.3 Main concerns

The main concerns regarding sharps waste are:

1. **Occupational safety**: Nurses, Auxiliary Nurse Midwives (ANMs), healthcare workers and recyclers can suffer from needle stick injuries. This can happen either just after the injection has been administered, during the disposal of the used syringe or even after disposal to those involved in recovering them. Of all the potential sources of infection transmission from bio-medical waste, needle sticks are of prime concern to the health staff and the community at large.

2. **Re-use potential**: In India, the sale of used, superior quality non AD syringes is lucrative. Therefore, there is a potential risk of illegal re-use, posing a risk to the entire community. The process of re-use of syringes involves a chain of recovery of intact and un-mutilated syringes, cursory cleaning in appearance, in some cases repacking, and re-entrance into the user chain. Clean looking syringes are known to command a higher price in the recycling market than mutilated ones, supporting the fear of their intrinsic public health risk.

3. **Safe disposal**: Used syringes need to be disposed of in an environmentally safe and pollution-free manner. Often, plastic syringes that contain polyvinyl chloride (PVC) are incinerated. Dioxins and furans and other toxic air pollutants are produced as emissions and/or in bottom fly ash. Exposure to dioxins and furans leads to significant adverse health effects. To ensure safe disposal, recycling after disinfection and mutilation or containment in pits are the possible options.

Any solution to handle sharps waste needs to encompass all three concerns and keep in mind the environmental and human health perspectives. The issue assumes added importance due to the quantum of waste generated from immunization programmes. In the context of developing countries, the nature of immunization programmes delivery in poorly equipped primary health centres scattered across the countryside or through door-to-door service provided by grassroots workers such as ANMs requires a simple, workable and affordable sharps management system. As an example, if the ANM is required to carry back the used syringe from the village back to the primary or the district health centre, adequate storage needs to be available.
The evolution of a separate category of medical waste within the municipal waste stream dates back to the late 1970s, when medical wastes, including syringes and bandages were washed up on beaches in the East Coast of the USA. The public outcry that followed led to the formulation of the US Medical Waste Tracking Act (MWTA), which finally came into force on 1 November 1988.

In India too medical waste was considered a part of the municipal waste till the problems associated with medical waste were realized. There was no legislation on Medical waste till the Ministry of Environment and Forest (MoEF) proposed the first draft rules in 1995. The rules recommended on-site incinerators for all hospitals with more than 50 beds. At the same time, in a public interest case, the Supreme Court of India, in March 1996, ordered the inclusion of alternate technologies and their standards in the Rules.

The second draft rules were notified in 1997. The final rules were notified on 20th July 1998 and were called Bio-Medical Waste (Management & Handling) or BMW Rules 1998 (see website at: http://dpcc.delhigovt.nic.in/act_bmw.htm).

Two other amendments have come through since. The first amendment notified on March 6th 2000 is referred to as Bio-Medical Waste (Management & Handling) (Amendment) Rules 2000. This amendment only changed Schedule VI of the rules, concerning having waste management facilities for treatment of waste. Even when the first deadline for eight cities with a population of more than 3 million was over, these cities had not been able to achieve anything significant in this direction. This amendment thus extended the deadline for implementation for the first phase.

The second amendment to the rules was notified on 2 June 2000 (called BMW Rules, 2000). Some of the major changes made included defining the role of the municipal body of the particular area, nominating Pollution Control Boards/Committees as Prescribed Authorities, addition of forms for seeking authorization to operate a facility and for filing an appeal against order passed by the prescribed authority.

The entire country now comes under the umbrella of the rules as 31 December 2002 was the deadline for the last phase of implementation of the rules covering all the health care institutions, cities, towns and villages nationally. Initially, the states were given the option to decide the Prescribed Authority. Most of the states either
nominated State Pollution Control Boards or the department of health as the prescribed authority. However, since the work involved a lot of technical intervention like monitoring the air emission from the incinerators, monitoring of the waste water effluent etc. eventually it was felt that pollution control departments would be appropriate as the prescribed authority and an amendment (Second Amendments to the Rules, June 2000) was made to this effect.

The fact that the Ministry of Family Health and Welfare was not as actively involved in determining the BMW Rules, as was the Ministry of Environment, explains, to some extent, some of the difficulties in implementing the Rules at the level of health care facilities.

2.1 Salient features of the Bio-Medical Waste (Management and Handling) Rules, 1998

- The rules apply to all persons who generate, collect, receive, transport, treat, dispose, store, or handle bio-medical waste in any form.

- It is the duty of the occupier, where required to set up requisite bio-medical waste treatment facilities like incinerator, autoclave, microwave for treatment of waste, or ensure requisite treatment of waste at a common waste treatment facility.

- Bio-medical waste is to be treated and disposed in accordance with Schedule I.

- Bio-medical waste has to be segregated at the point of generation in accordance with schedule II before its storage, transportation, treatment and disposal. The containers are to be labeled as per Schedule III.

- No untreated bio-medical waste can be kept beyond a period of 48 hours.

- **Prescribed Authority**: The State Pollution Control Boards have been nominated as the Prescribed Authority for granting authorization and implementing the rules. (As per the second amendment, June 2000).

- **Authorization**: Every occupier, except those providing treatment /service to less than1000 patients a month, and every operator of a bio-medical waste facility, needs to take authorization from a prescribed authority.

- **Advisory Committee**: The Government of every State/Union territory has to constitute an advisory committee. The committee will include experts from medical and health fields, from the municipal department and other related departments.

- **Annual Report**: Every occupier /operator has to submit an annual report to the prescribed authority in Form II by January 31st every year. The report will include information about the categories and quantities of bio-medical waste handled during the preceding year.
• **Maintenance of Records**: Every authorized person shall maintain records related to the generation, collection, reception, storage, transportation, treatment, disposal and/or any form of handling of bio-medical waste in accordance with the Rules and any guidelines issued.

• **Accident Reporting**: When any accident occurs at any institution or facility or at any other site where bio-medical waste is handled or during transportation of such waste, the authorized person has to report the accident in Form III to the prescribed authority.

• **Appeal**: Any person aggrieved by an order made by the Prescribed Authority under these rules may, within 30 days from the date on which the order is communicated to him appeal to the Government of State/Union territory.

• **Schedule I**: Describes different categories of bio-medical waste and their treatment options

<table>
<thead>
<tr>
<th>Option</th>
<th>Waste category</th>
<th>Treatment and disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category no.1</td>
<td>Human Anatomical Waste</td>
<td>Incineration; deep burial</td>
</tr>
<tr>
<td>Category no.2</td>
<td>Animal Waste</td>
<td>Incineration; deep burial</td>
</tr>
<tr>
<td>Category no.3</td>
<td>Microbiology and biotechnology waste</td>
<td>Local autoclaving/micro-waving/incineration</td>
</tr>
<tr>
<td>Category no.4</td>
<td>Waste sharps</td>
<td>Disinfection (chemical treatment; autoclaving/micro-waving) and mutilation/shredding</td>
</tr>
<tr>
<td>Category no.5</td>
<td>Discarded medicines and cytotoxic drugs</td>
<td>Incineration; destruction and drugs disposal in secured landfill</td>
</tr>
<tr>
<td>Category no.6</td>
<td>Soiled Waste</td>
<td>Incineration; autoclaving/micro-waving</td>
</tr>
<tr>
<td>Category no.7</td>
<td>Solid waste</td>
<td>Disinfection by chemical treatment; autoclaving/micro-waving and mutilation/shredding</td>
</tr>
<tr>
<td>Category no.8</td>
<td>Liquid waste</td>
<td>Disinfection by chemical treatment and discharge into drain</td>
</tr>
<tr>
<td>Category no.9</td>
<td>Incineration Ash</td>
<td>Disposal in municipal landfill</td>
</tr>
<tr>
<td>Category no.10</td>
<td>Chemical Waste</td>
<td>Chemical treatment; and discharge into drains for liquids and secured landfill for solids.</td>
</tr>
</tbody>
</table>

**Notes:**
- Chemical treatment means using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be seen that chemical treatment ensures disinfection.
- Mutilation/shredding must be such as to prevent unauthorized re-use.
- There will be no chemical pre-treatment before incineration. Chlorinated plastics shall not be incinerated.
- Deep burial shall be an option only in towns with a population of less than 0.5 million and in rural areas.
- The new guidelines rule against incineration as the disposal option for this category of waste.
2.2 Specific guidelines for handling sharps

**Definition of sharps:** The rules categorize sharps in Category No 4. Sharps are defined as comprising of needles, syringes, scalpels, blades, glass, i.e. anything that may cause puncture and cuts. These include both used and unused sharps.

**Segregation and storage:** The types of containers prescribed for waste sharps have to be puncture-proof and can be blue, white or translucent in colour.

Sharps need special attention while being segregated and stored because needles can act as a pool where pathogens may survive for a long time because of the presence of blood. Also the sharps can provide a direct route into the bloodstream by puncturing the skin. Syringes and needles must be damaged before they are put in containers, to prevent their re-use/resale. Sharps must always be kept in puncture-resistant containers to avoid injuries and infection to those handling them.

**Treatment:** The rules provide for disinfection and mutilation of sharps by either chemical treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. Treatment by autoclaving/ advanced autoclaves/ microwaving is also approved. Mutilation prior to disposal is mandatory to prevent any unauthorized re-use. Mutilation can be carried out at the point of generation by using needle cutters/ destroyers or centrally in the hospital by using shredders after disinfection of sharps.

**Final disposal:** After disinfection and mutilation of sharps they should be disposed in secured landfills as per the rules. As secured landfills are not available everywhere alternate systems recommended include:

(a) **Sharps pit:**

A specialized Committee constituted by the Ministry of Environment & Forests (MOEF) to formulate guidelines for implementation of Bio-Medical Waste (Management and Handling) Rules, 1998, prescribed the details of a sharps pit:

Blades and needles waste can be disposed in a circular or rectangular pit, after disinfection. Such a rectangular or circular pit can be dug and lined with brick, masonry or concrete rings. The pit should be covered with a heavy concrete slab.

![Diagram 1: Sharps pit as proposed by WHO](https://example.com/diagram.png)
which is penetrated by a galvanized steel pipe projecting about 1.5 m above the slab, with an internal diameter of up to 20 mm. When the pit is full it can be sealed completely, after another has been prepared.

(b) Encapsulation:

As per WHO (1999), encapsulation is recommended as the easiest method for the safe disposal of sharps. Sharps are collected in puncture-proof and leak-proof containers, such as high-density polythene boxes, metallic drums, or barrels. When a container is three-quarter full, a material such as cement mortar, bituminous sand, plastic foam, or clay is poured in until the container is completely filled. After the medium has dried, the containers are sealed and disposed of in landfill sites.

Diagram 2: Drum/cement encapsulation

Source: Safe Management of Wastes from Health Care Activities: WHO, 1999
3.1 Objectives of the study

(1) Document success stories of sound sharps management within and outside the health care facilities.

(2) Evaluate non-burn treatment and disposal technologies for the management of infectious sharps (advantages, disadvantages and system management required) in urban settings.

(3) Examine their compliance with existing policy and regulatory framework in India for sharps waste management.

(4) Assess the viability for potential material recovery from Auto-disable (AD) syringes.

3.2 Methodology

(1) Selection of health care institutions

(a) To have a national perspective of sharps management in urban areas around the country, 13 health care institutions located in six cities were selected.

(b) The health care institutions selected were identified by the existing network of individuals and organizations working in the area of medical waste and through available literature. The criteria for selection were based on functionality of the sharps management practiced within and outside the hospital, the treatment technology used, their type and size.

(c) To determine the present situation of sharps management in smaller health care institutions like nursing homes and clinics, in-depth interviews were conducted with medical professionals/waste management in-charge of the units. Only units with immunization and laboratory services, and which generated sharps waste regularly, were selected.

(d) The main types of sharps selected for the study were those generated by injections during curative and immunization practices.
(e) Research Location: To document successful sharps management practices, the health care/treatment facilities and reprocessing/smelting units selected for the present study were located in Delhi, Bangalore, Hyderabad, Mumbai Chennai and Kolkata.

Table 2: List of the facilities surveyed in this Study

<table>
<thead>
<tr>
<th>Facility/Institution</th>
<th>Location</th>
<th>No. of beds</th>
<th>Reason for selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lions Hospital</td>
<td>New Delhi</td>
<td>64</td>
<td>Sharps pit</td>
</tr>
<tr>
<td>Holy Family Hospital</td>
<td>New Delhi</td>
<td>300</td>
<td>Encapsulation Deep burial</td>
</tr>
<tr>
<td>St. Stephen’s Hospital</td>
<td>New Delhi</td>
<td>590</td>
<td>Sharps Pit</td>
</tr>
<tr>
<td>Sir Ganga Ram Hospital</td>
<td>New Delhi</td>
<td>500</td>
<td>Encapsulation and Deep burial</td>
</tr>
<tr>
<td>Ram Manohar Lohia Hospital</td>
<td>New Delhi</td>
<td>937</td>
<td>Sharps pit</td>
</tr>
<tr>
<td>Ramaiah Medical College</td>
<td>Bangalore</td>
<td>750</td>
<td>Sharps pit</td>
</tr>
<tr>
<td>Command Hospital</td>
<td>Bangalore</td>
<td>830</td>
<td>A combination of technologies-Hydroclave™ Microwave Deep burial</td>
</tr>
<tr>
<td>Sundaram Medical Foundation</td>
<td>Chennai</td>
<td>125</td>
<td>Shredding Smelting</td>
</tr>
<tr>
<td>Tata Memorial Hospital</td>
<td>Mumbai</td>
<td>450</td>
<td>Hydroclave™ system</td>
</tr>
<tr>
<td>Centralized Facility Medi Care Incin Pvt</td>
<td>Hyderabad</td>
<td>10 000</td>
<td>Handling large volume of sharps</td>
</tr>
<tr>
<td>Centralized Facility Multiclave Pvt Ltd</td>
<td>Hyderabad</td>
<td>10 000</td>
<td>Handling large volume of sharps</td>
</tr>
<tr>
<td>Sub-Divisional Hospital, District Diamond Harbour</td>
<td>Kolkata</td>
<td>125</td>
<td>Use of alternative technologies in handling sharps</td>
</tr>
<tr>
<td>Jawaharlal Nehru Memorial State General Hospital, District Kalyani, West Bengal</td>
<td>West Bengal</td>
<td>550</td>
<td>Use of alternative technologies in handling sharps</td>
</tr>
</tbody>
</table>

(2) Documentation of sharps management practices in the health care facilities/ reprocessing units by using different research tools and indicators described below

(a) Literature review: An Extensive literature review was carried to collect information in the country.

(b) Open-ended questionnaire: To seek views of experts in the field of medical waste open-ended questionnaires were posted and personal meetings were organized. This helped in getting an overall sharps management perspective of different stakeholders working in the field.
(c) **Hospital visit:** All the 13 health care institutions selected for the study were visited and their waste management system observed. Special attention was paid to the sharps management system followed in the hospital. The path traversed by the sharps from the point of generation to their final disposal was evaluated. Photographs were taken to record these aspects.

(d) **Focus group discussions/in-depth interviews:** Personnel working in health care institutions, material recovery units and waste handlers and health institutions were interviewed to get a better insight into the existing system.

   In-depth interviews were conducted with each category of staff including hospital administrators, doctors, nursing staff, housekeeping personnel and technology operators in the health care institutions. These interviews helped in assessing the elements that led to the Facility of the sharps management systems in their institutions.

   In-depth interviews were also conducted with doctors, waste pickers/sorters and recyclers to understand the aspects of waste reprocessing.

   Focus Group Discussions (FGDs) were conducted with specific groups of health care workers and those in the material recovery industry to collect data on different aspects of sharps management and to assess the acceptability of AD syringes within the health care institutions and the material recovery industry. Two FGDs were conducted with health care workers mainly comprising nurses and those responsible for waste management in the facility.

(e) **Review committee meeting:** To get a feedback on the work, review committee meetings were organized with various stakeholders including Srishti, Ministry of Health and Family Welfare, WHO, and the Central Pollution Control Board. This was helpful in understanding gaps in the study and for incorporating various suggestions.

(f) **Indicators:** Sets of indicators were framed to assess the sharps management practices in different health care institutions as well as in the material recovery industry. These indicators were prepared to evaluate the different aspects related with sharps management from the point of generation, collection, storage, transportation, treatment and disposal. Other important aspects included occupational safety, training and awareness, economics of sharps management and compliance with the regulations.

   The responses to the indicators were graded in the form of ‘Yes and No’, along with the comments to each indicator. The responses were used for the overall assessment of the indicators.

   Based on the treatment and disposal options and their point of use, the indicator parameters varied slightly. This methodology helped in easily and more effectively evaluating the methods.
The indicators used for the present study looked into the following areas:

1. **Acceptability**: Acceptance of the treatment method by health workers and operators, the types of waste that can be treated, user-friendly design of the equipment, acceptability to the community around the health facility.

2. **Access**: Possibility of other nursing stations/health facilities to benefit from the installed equipment through a common system of waste collection.

3. **Availability**: The availability of the treatment technologies in terms of ease of availability like manufactured locally, various vendors etc. was assessed.

4. **Occupational safety**: The safety of health workers and the public at large while using the technology and to later exposure was assessed. Use of protective gear, limited handling of contaminated waste, disinfection of the waste, proper final disposal or material recovery, etc.

5. **Sustainability**: The cost of establishing and running the technology, availability of a budget to address current costs, manpower (responsibility assigned and tasks clearly defined), operating procedures defined to manage waste including operating and maintenance of the equipment in place, years in use, regular training and monitoring.

6. **Regulatory acceptance**: Compliance of the technology with Bio-Medical waste (Management and Handling), Rules, 1998 was assessed.

The questionnaires and the indicators are attached in the annex.

(3) **Non-burn technologies selected for the study**

As the focus of the study was on non-burn technologies, such technologies approved by the Central Pollution Control Board (CPCB) were selected. These include needle cutters/destroyers, chemical disinfection, autoclave, advance autoclaves and microwave. To assess the performance of these technologies, more than one institution using the technology was included in the study.

(4) **Final disposal options**

The methods selected include deep burial pits, encapsulation and material reprocessing industry. Though the Bio-Medical Waste Rules, 1998, do not mention these methods, they are widely used and need to be evaluated for future replication.
The hospitals chosen as case studies have adopted safe systems and methods of managing the sharps waste being generated in their institutions. The research locations were spread over India to get an overall picture of waste management and to document different practices that have been adopted throughout the country.

4.1 Lion’s Hospital, New Delhi

This is a 64-bedded ‘Lions Service Trust’ hospital. Other than providing medical care, the hospital is interested in environmental issues. The hospital has a sound system of waste management in place, with the following salient features:

**Bio-medical waste management**

The hospital provides different coloured bins for each type of waste. After decontamination, the waste is transported from different points of generation to the final storage site manually by a specially appointed housekeeping staff. Later, the waste is handed over to a centralized facility for treatment and final disposal.

**Table 3: Waste management system in Lion’s Hospital, New Delhi**

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow</td>
<td>Centralized facility for incineration</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves, blood and urine bags culture plates)</td>
<td>Blue</td>
<td>Centralized facility for autoclaving and shredding</td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture proof containers</td>
<td>Metal sharps are disinfected and mutilated at source</td>
</tr>
<tr>
<td>General waste</td>
<td>Black</td>
<td>No treatment as this category of waste is considered non-infectious in nature</td>
</tr>
</tbody>
</table>
average, the hospital generates around 3 to 4 Kgs of infectious waste and administers 10 injections each day.

**Sharps management**

The hospital has provided puncture-resistant containers and needle cutters at seven different points of generation. The needle destroyer is a device which cuts/destroys the needle and the tip of the syringe by an electric arc or by mechanical blades. The destroyers were initially provided in the main areas of sharps generation like the laboratory and the casualty ward, but later, recognizing their necessity, they were procured for the entire hospital. The needle cutters have been in use by the hospital for more than two years. The hospital finds the needle cutters an effective mode of mutilating the needles and syringes effectively. After mutilation, the sharps are subjected to 1% bleach solution for chemical disinfection and placed in puncture-resistant containers.

For occupational safety of the health workers, personal protective gears and Hepatitis-B vaccines have been provided to the staff. Recapping of needles is discouraged in the hospital but in case of any recapping or accidental needle stick injury, no follow-up action is being taken by the hospital. The hospital has no reporting format for needle pricks and other injuries caused by sharps.

**Final disposal of sharps**

For the final disposal of sharps, a sharps pit was constructed by the hospital two years ago. All metal sharps including needles, blades and lancets are sent to the pit.

The pit is 3ft x 3ft x 3ft and is constructed of brick and cement. The cost of construction was Rs.500 (USD 10). The pit is located at the corner of the main garden of the hospital and is inaccessible to health care workers and scavengers as it is located at the entrance of the institution and there is a guard always present at the gate. The pit is covered, and has an opening at the top, which is covered by a slab.
As around 100 grams of sharps are generated in a day, they are collected every three days and disposed twice a week into the sharps pit. No chemical disinfectant is added along with the sharps as the disinfection is carried out at the point of generation. The hospital opted to use a pit for sharps as it felt that it was the easiest way of disposing them. Once the existing pit gets filled it will be cemented. The disinfected and mutilated plastics (syringes) are bought by a scrap dealer who also collects cardboard and paper. For the hospital, the sharps pit is an interim solution; they plan to join a centralized facility, to take some of future needs.

4.2 Holy Family Hospital, New Delhi

Holy Family is a 300-bedded multi-specialty hospital offering three streams of treatment allopathic, homeopathic and ayurvedic. It also has a nursing school and offers courses for other paramedical fields.

**Bio-medical waste management**

The hospital has a well-defined system of waste management. Waste is segregated at the point of generation into infectious, infectious plastics and general waste. Syringes and needles are separated by needle destroyer and stored in puncture-proof containers. The infectious waste is collected from the point of generation by a designated housekeeping staff in a trolley, specifically for the purpose, and transported to the main hospital dumpsite by the housekeeping staff. Infectious waste is sent for incineration to a centralized facility. Disinfected and shredded plastics are handed over to a waste contractor and general waste is disposed into municipal dumps.

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow</td>
<td>Sent for Incineration to the centralized facility</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves, blood and urine bags, culture plates)</td>
<td>Twin bin with chemical disinfectant</td>
<td>Chemical disinfection and shredding</td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture-proof containers</td>
<td>Metal sharps are mutilated, chemically disinfected and handed over to a waste contractor</td>
</tr>
<tr>
<td>IV bottles &amp; disinfected plastics</td>
<td>Translucent/Transparent container</td>
<td>No treatment as this category of waste is considered non-infectious in nature.</td>
</tr>
<tr>
<td>General waste</td>
<td>Black</td>
<td>No treatment.</td>
</tr>
</tbody>
</table>
Training has been imparted to the entire staff in the hospital. The subject has also been incorporated in the curriculum of the nursing school. Posters have been placed throughout the hospital as constant reminders.

Regular monitoring of the system by the waste management committee as well as an outside agency has helped the hospital in maintaining a sound waste management system.

**Sharps management**

The hospital initiated a system of sharps management as early as 1998. The hospital procured needle destroyers and placed puncture-resistant containers, twin bins and 1% Sodium Hypochlorite for disinfection of sharps at the point of generation. Initially, when the needle destroyers were procured, there was resistance from the staff using it and also the breakdown rate was high. With time, the resistance has receded and the hospital has procured more such equipment.

Sharps are destroyed either immediately after use or in batches. When the sharps are destroyed in batches they are placed on a thick piece of thermocol with the needles piercing into the sheet. Later, the sharps are destroyed and the thermocol piece is disinfected.

A designated housekeeping staff transports the sharps in a bucket placed on a trolley to the final disposal site. The trolley is cleaned regularly with soap and water and is not used for any other purpose. The wastewater goes down the drain.

Breadboxes are used as puncture resistant containers to store metal sharps at the point of generation and chemical disinfectant is added to these containers to ensure disinfection at source.

To ensure occupational safety of these workers, special protective clothing is provided by the hospital. Hepatitis B and Tetanus vaccinations have been given to the staff handling waste. In case of any injury, the waste management committee in-charge has to be informed and, if required, the hospital provides post prophylaxis measures.
Final disposal

The hospital generates one tin (approx 15 litres capacity) of sharps in a week. For disposal of sharps waste, encapsulation was carried out initially in the hospital. Around 35 tins, which were sealed from the top, were placed in the foundation of the new building. Presently, the hospital is handing over its sharps waste to the waste treatment agency. The hospital recommends smelting as the final disposal method.

4.3 St. Stephen’s Hospital, New Delhi

St. Stephen’s established in 1887, is a 590-bedded multi-specialty hospital offering medical care to a large number of people. The hospital is equipped with all modern technologies. The hospital runs a nursing school, offers para medical courses and post-graduate medical teaching.

Bio-medical waste management

The hospital has a well-defined system of waste management. Adequate numbers of bins are provided at each point of generation for waste segregation. The waste is carried to the final disposal site by trained housekeeping staff in a dedicated waste trolley. At the final disposal site infectious waste (Category 1 and 2) is stored separately to be handed over to the centralized facility for incineration. Other infectious waste like plastics generated from wards like syringes, tubes, urine bags etc. is autoclaved before being shredded.

Training on bio-medical waste management has been imparted to all the staff in the hospital. Constant awareness about the subject is spread through posters, which are placed at different points within the hospital. The hospital also has a waste management committee, which separately monitors the system.

Sharps management

The hospital initiated a system of sharps management as early as 1997 when it procured needle destroyers for the main areas of sharps generation. In 1999, each point of generation was provided with a needle destroyer (a total of 40) to ensure
that no sharps, especially needles and syringes, are discarded without mutilation. Initially, when these instruments were procured there was resistance from the staff about using them as they feared sparks and short-circuits. Also, the breakdown rate of these instruments was high. With time, the resistance has receded. The hospital’s bio-engineering division regularly maintains the needle destroyers resulting in almost no breakdown. In case of any breakdown, the hospital has five spare needle destroyers.

The sharps are stored at the point of generation in special puncture-resistant containers with a single opening of 1" radius. Chemical disinfectant is added to the container to ensure disinfection at source.

Later, a specially designated housekeeping staff person transports the sharps in a bucket placed on a wheelbarrow to the sharps pit. The bucket and the wheelbarrow are cleaned regularly with soap and water and not used for any other purpose.

To ensure occupational safety of these workers, special protective clothing is provided by the hospital, along with Hepatitis B and Tetanus vaccinations to the staff handling waste. The hospital also has a needle stick injury-reporting format and provides post-prophylaxis measures in case of a needle stick injury.

**Final disposal**

As the total quantity of sharps generated by the hospital is around five litres/day, there was a proposal to have a sharps pit, which would contain the sharps for at

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow</td>
<td>Incineration</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves, blood and urine bags, culture plates)</td>
<td>Twin bin and later transferred to a translucent container</td>
<td>Chemical disinfection, autoclaving and shredding</td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture-proof containers</td>
<td>Metal sharps are mutilated, chemically disinfected and disposed in the sharps pit</td>
</tr>
<tr>
<td>General waste</td>
<td>Black</td>
<td>No treatment</td>
</tr>
</tbody>
</table>
least 4-5 years. Though the hospital feels that a sharps pit solves the problem of final disposal, no more pits can be constructed due to lack of space. It would thus prefer sending the metal sharps for smelting.

The disinfected syringes are further autoclaved and shredded before being sent for recycling.

**Details of the sharps pit**

- The sharps pit is located in a corner of the hospital behind the parking space.
- The initial cost of constructing the pit was Rs 30,000 (800 US$).
- The pit is made of reinforced concrete, and is leak-proof and water-proof and is painted black.
- The walls of the pit are 4 ½ inches thick.
- The pit has a 1" x 1" opening.
- At both sides of the opening there are three-inch slabs of RCC.
- A concrete slab is placed at the foundation of the pit, which makes it leak-proof.
- To the left of the opening, there is a 1feet diameter vent pipe, for gases to escape if any.
- A 3 to 4 mm thick MS plate with lockable arrangements covers the opening of the pit because of which it is water-resistant.
- The pit is painted yearly to make it endure wear and tear.
- No disinfectant is added to the pit as the sharps before being disposed are disinfected.
- During the last six months the pit has been one tenth full.
- The hospital authorities feel that the pit would get filled within the next three years. They are therefore considering handing over collection of sharps to an outside agency.
4.4 Sir Ganga Ram Hospital, New Delhi

The Sir Ganga Ram hospital is one of the country’s most prestigious private hospitals with 500 beds. The hospital provides multi-speciality health care facilities and also offers different postgraduate courses in medical and para-medical sciences.

Bio-medical waste management

The hospital has a well-defined system of waste management. Waste is segregated at the point of generation into infectious, infectious plastics, sharps and general waste. Sharps are destroyed by needle destroyer/cutters and stored in puncture-proof containers. The infectious waste and other infected plastics are collected in different wheelbarrows. General waste is carried to the final disposal site by the housekeeping staff of the respective units. The plastics and sharps are disinfected, autoclaved and shredded before being handed over to a waste dealer; infectious waste is sent to a centralized facility for final disposal. The sharps are placed in a sharps pit/handed over to a contractor while the general waste is disposed into municipal dumps.

Training on the subject has been imparted to the nurses and housekeeping staff. Posters at each point of generation serve as a constant reminder to the staff and the public at large. The hospital has a waste management committee with a nodal officer, who looks after various waste management practices. Regular monitoring by the infection control nurses have helped in developing a sound system of waste management in the hospital.

Table 6: Waste management system in Ganga Ram Hospital, New Delhi

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow</td>
<td>Incineration</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves, blood and urine bags, culture plates)</td>
<td>Twin bin with chemical disinfectant and later transferred to containers lined with red colour</td>
<td>Chemical disinfection, Autoclaving and shredding</td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture-proof containers</td>
<td>Metal sharps are mutilated, chemically disinfected, autoclaved and handed over to a waste contractor</td>
</tr>
<tr>
<td>General Waste</td>
<td>Black container</td>
<td>No treatment as this waste is non-infectious in nature</td>
</tr>
</tbody>
</table>

Sharps management

The hospital initiated a system of sharps management as early as 1995 when the hospital procured needle destroyers for the main areas of sharps generation. Later,
by 1999 each point of generation was provided with a needle destroyer to ensure that no sharps, especially needles and syringes, are discarded without mutilation. In case of any breakdown, the hospital has spare needle destroyers.

Needles, after being mutilated by the needle destroyer are placed in puncture-resistant containers (breadbox) containing sodium hypochlorite for disinfection. Syringes are placed in a twin bin with inner sieved bin that contains 1% sodium hypochlorite for their disinfection at source. Specially designated housekeeping staff carries the sharps in a plastic bucket and syringes in a covered wheelbarrow to the final disposal site where the needles and syringes are autoclaved in separate cycles and the syringes are shredded before being sent for recycling.

To ensure occupational safety of workers, special protective gear are provided by the hospital and Hepatitis B and Tetanus vaccinations have been given to the staff handling waste. The hospital also has a needle stick injury-reporting format and provides post-prophylaxis measures in case of a needle stick injury.

Final disposal

The total quantity of metal sharps generated by the hospital is around 5-6 Kgs/day. The hospital had constructed a 3ft x 3ft x 5ft sharps pit within the hospital premises. The pit was estimated to last for two years but due to an increase in the number of injections, it only lasted for six months.

The sharps pit constructed by the hospital is located near the incinerator site and is not accessible to hospital staff and outsiders. It was a simple pit lined with bricks. A concrete slab with a small opening covered the pit which was not leach-proof as it was not scientifically designed. Though the hospital feels that a sharps pit solves the problem of final disposal, no more pits can be constructed because of lack of space. The construction of a new pit is underway and, for the time being, the sharps waste is being handled by a contractor.

The hospital also encapsulated around 25 plastic jerry cans with 2 kgs of sharps in each can under the new building coming up in the hospital. The cans were covered
from the top and buried under the foundation of the new building. The encapsulation could be practiced only for a short period. The hospital has looked into different solutions and would prefer sending the metal sharps for smelting/recycling.

4.5 Dr Ram Manohar Lohia Hospital, New Delhi

Dr Ram Manohar Lohia Hospital is a multi-specialty hospital with 937 beds. This is one of the prestigious Central Government hospitals because of its strategic location, availability of a Nursing Home facility, many super specialties like Neuro Surgery, Cardiology, Burn & Plastic Surgery and a Finitive Care Centre. The hospital has laboratory and radiological investigation facilities including whole body C.T.Scan and ultrasound. The hospital also provides round-the-clock emergency services and a blood banking facility.

Bio-medical waste management

Segregation is being practiced at the point of generation in the hospital. The waste is segregated into infectious, infectious plastics, sharps and general waste. Infectious plastics and sharps are disinfected with 1% bleach solution at the point of generation.

The waste is transported from the point of generation to the final disposal site in wheelbarrows. The infectious waste and general waste are transported by a group of specially trained housekeeping staff in the hospital while the housekeeping staff of the respective units transports the infectious plastics and sharps. At the final disposal site the infectious waste is incinerated, infectious plastics are treated in the microwave and then shredded. Sharps are disposed in the sharps pit.

The hospital staff has been trained on issues of waste management. Posters depicting good practices of waste management have been placed in the entire hospital and serve as a constant reminder.

Table 7: Waste Management system in Dr Ram Manohar Lohia Hospital, New Delhi

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow container</td>
<td>Incineration</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves)</td>
<td>Twin-bin with chemical disinfectant and later transferred to blue coloured bins</td>
<td>Chemical disinfection, microwaving and shredding</td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture-proof containers</td>
<td>Metal sharps are mutilated, chemically disinfected and placed in a sharps pit</td>
</tr>
<tr>
<td>General waste</td>
<td>Black bins</td>
<td>No treatment it is considered non-infectious in nature</td>
</tr>
</tbody>
</table>
Sharps management

The hospital has provided needle destroyers and puncture-proof containers at each nursing station. The needle destroyers are reported to work efficiently with almost no breakdowns in the past two years. The hospital has an extra stock of destroyers that can be used in case of any malfunctioning of the existing ones. The hospital has had good experience with these machines as compared to other hospitals where similar machines do not work very well. The needle destroyers are electrically operated with a charger attached to them. Thus, in case of electricity failure, the machine remains functional.

At the point of generation, the burnt needles are disinfected by 1% bleach solution, which are placed in a puncture-resistant container that has a narrow opening. The syringes are disinfected before being finally disposed. The twin-bin system is adopted using chemical disinfection. Sodium hypochlorite solution and Savalon® are used as disinfectants.

The sharps waste is carried from the point of generation to the final disposal site by housekeeping staff of the respective units once a day in open wheelbarrows. The waste handlers have been provided with vaccination and personal protection gear including masks and gloves. Needle-stick injuries are reported to the authorities.

Final disposal

The total quantity of metal sharps generated in the hospital varies between 3-4 Kgs/day. The metal sharps, after disinfection at source are finally disposed into a sharps pit which has been constructed at the corner of the hospital near the incinerator site. It is not accessible to the hospital staff and the public at large.

The hospital constructed two pits with dimensions of 6 x 3 x 3 ft. These are made of concrete and are supposed to be leach proof. The pits are covered by concrete and have a pipe opening, through which sharps are disposed. The pipe has a lid, to facilitate locking. The expected life of the small pit was 3 years but the pit filled up in 10
months. Similarly the expected life of the bigger pit was 6-8 years but is near completion in a period of 1.5 years. The reasons attributed for the short life of the pit were mixed waste being filled in the pit and pilling of the waste near the pit opening and very little waste in other areas of the pit. The cost of construction of the bigger pit was around Rs.50,000/- (1000 US$).

The hospital chose sharps pit as the final waste disposal option because the sharps are stored securely and not accessible. Due to lack of space, no more sharps pit can be constructed in the hospital.

The syringes are subjected to treatment in the microwave and shredded into small granules, which are handed over to the material recovery industry.

Other infectious wastes are incinerated and general waste is disposed into the municipal waste dumps.

4.6 M.S. Ramaiah Medical College, Bangalore, Department of community medicine

The Health Care Waste Management Cell (HCWMC) was initiated in the college in July 1998. The cell had representatives from different backgrounds and organizations. This endeavour towards the safe management of healthcare waste was undertaken at the initiative of the Department of Community Medicine, in collaboration with the Bangalore City Corporation, Tata Energy Research Institute, WasteWise etc. The Department of Environment, Ecology and Forest, Government of Karnataka supported and funded the exploratory study on health waste disposal in the city of Bangalore and also the information learning units for training for Safe Management of Healthcare Waste. These two units resulted in initiating a network of individuals and organizations in Bangalore city and catalyzed ongoing endeavours. This also resulted in conceptualizing the Malleshwaram Health Care Waste Management Project (MHCWMP). Seventy-five institutions were included in the project activities which included a) waste sharps programme and b) recyclables and infectious waste programme.
**Bio-medical waste management**

The HCWMC initiated the system at the Ramaiah Medical College which is a 750-bedded medical teaching tertiary care centre. In the hospital, segregation is practiced at the point of generation. The waste is segregated into infectious, infectious plastics, sharps waste and general waste.

Infectious plastics and sharps are disinfected with 1% bleach solution. The hospital staff has been trained on the issues of waste management. Posters depicting good practices of waste management have been placed in the entire hospital.

**Table 8: Waste management in Ramaiah Medical College, Bangalore**

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow</td>
<td>Incineration</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves, blood bags, culture plates)</td>
<td>Blue</td>
<td></td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture-proof containers</td>
<td>Sharps Pit</td>
</tr>
<tr>
<td>General Waste</td>
<td>Black container</td>
<td>No treatment as this waste is non-infectious in nature</td>
</tr>
</tbody>
</table>

**Sharps management**

Sharps generated in the health care facilities were collected at the point of generation in puncture-proof containers and chemically disinfected in 1% bleach solution. The metal sharps, mainly needles, were stored along with glass sharps comprising broken ampoules and glass pieces. The needles were detached manually as the waste management cell discourages the use of needle destroyers/ cutters based on their experience. The cutters were found to be unsuitable and un-economical, as they did not function properly.
Final disposal
The sharps are carried from the generating sites to the final disposal site for deep burial in the sharps pit constructed in the medical college campus. The disinfected syringes and other plastic waste are mutilated manually and handed over to a waste contractor for recycling.

The 10 ft. x 10 ft. x 12 ft. sharps pit, constructed in June 1999 lasted for two years. The expected life of the pit was over three years but due to more than the expected health care facilities sending their sharps waste, the pit got full earlier than expected.

The cost of construction of the pit was Rs.35,220 (approx 800 US$) and the recurring cost incurred by the smaller health care facilities was around Rs.2/ (4 US cents) bed/day for transportation of the disinfected plastics and sharps waste. The disinfected plastics were manually mutilated and handed over to the recycling industry. The sharps (metal and glass) are still securely stored in the sharps pit, as the recycling industry has not taken up the sharps for reprocessing.

Plastic waste, consisting of syringes and IV fluid bottles are taken to the plastic recycling unit, where they are shredded for further processing. The recycling unit in turn sells them to another unit where they are used to make plastic pellets. IV fluid bottles fetch Rs 20 (US$0.43) a kg and syringes fetch Rs 13.20 (US$ 0.29) per kg.

Since the Malleshwaran project was a demonstration model, once the sharps pit got full, the waste from the health care facilities is being handed over to the centralized facility for final treatment and disposal.

4.7 Air Force Command Hospital, Bangalore
The Air Force Command Hospital Bangalore (CHAFB), is an 830-bedded multi-discipline, super-specialty tertiary care hospital with post-graduate teaching facilities. The hospital is spread over 79 acres of land and was selected as one of the hospitals for a WHO-supported project on Hospital Waste Management in India. The project continued for one year (from January to December 1999). The hospital has a waste management committee.

Bio-medical waste management
The hospital generates approximately 1.12 kg waste/bed/day and uses the following system of waste management:

Sharps management
The hospital generates a large quantity of different kinds of sharps, which are stored in puncture-resistant containers. All broken glassware items are disposed in pearl pet jars filled with 2/3rd Savalon®l of 2.5% concentration. All metallic sharps after mutilation by needle destroyer/scissors are disposed in pearl pet jars specifically meant for metallic sharps, filled 2/3 with 2.5% Savalon®l.
A waste collection team collects metal and glass sharps daily from different areas within the hospital in two different plastic buckets. It also changes the Savalon® solution every day in these areas. Records on the quantity of sharps generated and their mutilation and disinfection are maintained by the hospital.

Adequate protective gear has been provided to the health care workers handling sharps during treatment or investigation processes. Housekeeping staff, while handling sharps, wear heavy-duty yellow gloves along with a mask.

The hospital has a reporting format covering any kind of injury sustained during procedures.

**Final disposal**

All glass sharps are collected, treated and stored centrally at the final storage site and then sold to the vendor monthly. All metallic sharps are also collected, treated and stored centrally. Earlier, the hospital was sending the mutilated and disinfected needles to the landfill but at the time of the visit metal sharps were being immersed in concentrated sulphuric acid for 40 hours in which they dissolve completely. The sulphuric acid residue is later neutralized and after testing the Ph level, it is drained.

The Command Hospital follows a multi-option approach for final disposal. The hospital has an oil-fired incinerator, a Hydroclave™, a microwave, an autoclave, a plastic shredder, and carries out vermicomposting as well.

**4.8 Sundaram Medical Foundation, Chennai**

This is a 125-bedded multi-specialty hospital offering the latest healthcare facilities and is well equipped with modern equipment.

---

**Table 9: Waste management system in Air Force Command Hospital, Bangalore**

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (human tissues, body parts, placenta)</td>
<td>Yellow</td>
<td>Incineration</td>
</tr>
<tr>
<td>Infectious plastic waste</td>
<td>Blue</td>
<td>Waste is treated in 5% sodium hypochlorite solution and then shredded</td>
</tr>
<tr>
<td>Infected waste (gauze, cotton, dressing soiled with body fluids)</td>
<td>Red</td>
<td>Red waste from OT, Lab, Labour Room and isolation ward is incinerated, while waste from other wards is hydroclaved</td>
</tr>
<tr>
<td>General Waste</td>
<td>Green</td>
<td>hydroclaved with red waste and also vermicomposted</td>
</tr>
<tr>
<td>Sharps</td>
<td>Pearl pet jars</td>
<td>Treated by 2.5% Savalon®</td>
</tr>
</tbody>
</table>
Bio-medical waste management

The hospital has a well-established system of waste management. Segregation of waste is carried out at the point of generation and the waste is stored in covered bins lined with colour-coded bags as described below.

The segregated waste is collected twice a day from each point of generation by the housekeeping staff in specially constructed trolleys carrying different coloured bins, meant for each kind of waste. At the final disposal site, the red bag waste is autoclaved and yellow bag waste with pathological tissues is stored in a refrigerator before being sent to the crematorium for final disposal.

Training and regular orientation programme on medical waste management are organized in the hospital for the staff and posters have been placed at each point of generation. Monitoring of the system by the infection control committee helps in ensuring proper functioning of the system.

Protective gear and Hepatitis B vaccine have been provided to all health care workers handling waste. In case of any needle-stick injury, the staff reports it to the infection control committee members and post-prophylaxis is given if necessary.

Sharps management

Metal and glass sharps are segregated at source and are not given any treatment. They are stored in puncture-resistant bins, which are foot-pressed. The sharps, on

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow</td>
<td>Pathological tissues are sent to a crematorium and the cotton and gauze pieces are autoclaved.</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves, blood and urine bags culture plates)</td>
<td>Red</td>
<td>Autoclaved and shredded</td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture proof containers</td>
<td>Metal sharps are autoclaved and shredded.</td>
</tr>
<tr>
<td>IV bottles</td>
<td>Black</td>
<td>No treatment as this category of waste is considered non-infectious in nature.</td>
</tr>
<tr>
<td>General waste</td>
<td>Black</td>
<td>No treatment as this category of waste is considered non-infectious in nature.</td>
</tr>
</tbody>
</table>

Table 10: Waste management system in Sundaram Medical Foundation, Chennai
Alternate days are collected in bigger bins by the housekeeping staff. The metal sharps are autoclaved and shredded while the glass sharps are handed over directly to a waste contractor.

**Final disposal**

The disinfected and mutilated metal sharps are stored in thick cardboard boxes, which are then sent to an iron foundry for smelting. To ensure that the quality of the steel produced is not affected, only 10 kg of metal sharps are sent in 15 days to the hospital-owned foundry.

The foundry is not willing to accept waste from other health care institutions as they are not sure of the level of disinfection and this would increase the risk associated with handling sharps and also could affect the quality of the iron.

**4.9. Tata Memorial Hospital, Mumbai**

Tata Memorial Hospital is one of the most prestigious health care institutes for cancer treatment and research facilities in India. The hospital has 450 beds.

**General waste management**

The waste is segregated into different categories at the point of generation.

The average amount of infectious waste generated daily in the hospital is 300 kg. All anatomical waste and cytotoxic waste is sent to the municipal crematorium.
The radioactive waste generated is transported outside the area in duly shielded containers and sent to the Bhaba Atomic Research Centre (BARC). The radioactive waste is produced as a result of in-vitro analysis of body tissues and fluid, in vivo-organ imaging and tumor localization and various investigative and therapeutic practices, which include radiotherapy and nuclear medicine.

There is no separate cycle being run for sharps wastes and they are treated together with other categories of waste in the Hydroclave™.

### Sharps management

At the point of generation, the hospital has provided sharps containers of 1 kg, 2 kg and 5 kg capacity, which are placed in different wards as per requirement. Average weight of sharps containers is: 1 kg capacity averages 40 gms; 2 kg capacity averages 80 gms; 5 kg capacity averages 200gms.

These sharps containers have been designed by the hospital. The lid of the container has an opening in which the needles are inserted and broken. The sharps are not chemically disinfected at the point of generation as all the waste is centrally treated in the Hydroclave™.

---

**Table 11: Waste management system in Tata Memorial Hospital, Mumbai**

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues, cotton and gauze pieces)</td>
<td>Yellow</td>
<td>Pathological tissues are sent to a crematorium and the cotton and gauze pieces are hydroclaved</td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes, gloves, blood and urine bags and culture plates)</td>
<td>Red</td>
<td>hydroclaved and shredded</td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture proof containers</td>
<td>Metal sharps are hydroclaved and shredded</td>
</tr>
<tr>
<td>General waste</td>
<td>Black</td>
<td>No treatment as this category of waste is considered non-infectious in nature</td>
</tr>
</tbody>
</table>

The radioactive waste generated is transported outside the area in duly shielded containers and sent to the Bhaba Atomic Research Centre (BARC). The radioactive waste is produced as a result of in-vitro analysis of body tissues and fluid, in vivo-organ imaging and tumor localization and various investigative and therapeutic practices, which include radiotherapy and nuclear medicine.

There is no separate cycle being run for sharps wastes and they are treated together with other categories of waste in the Hydroclave™.
All the health care workers handling waste have been provided with proper protective gear and vaccination against Hepatitis-B. The hospital has a needle-stick reporting format and all employees are to report to the infection control in-charge in case of any sharps injury.

**Final disposal**

The sharps containers are carried manually to the Hydroclave™ site and emptied into large bags containing all kinds of infectious waste. Thus the sharps are treated in the same cycle along with other waste streams as no separate cycle is being run for different waste types. Later these bags are hyroclaved and shredded. The disinfected and shredded waste is then sent to the municipal landfill for final disposal.

The Tata Memorial Hospital has installed a Hydroclave™ (advanced autoclave) for treating its non-pathological waste. The Hydroclave™ is a double-walled cylindrical vessel, horizontally mounted. The vessel is fitted with a mixing arm that rotates slowly inside the vessel. When steam is introduced in the vessel jacket, it transmits heat rapidly to the wet, fragmented waste, which, in turn produces steam of its own.

The waste after treatment and shredding is transported to the dustbin on a conveyer belt. This dustbin, which is of one ton capacity, is collected by the Bombay Municipal Corporation once a week.

**Table 12: Description of the Hydroclave™ at Tata Memorial Hospital, Mumbai**

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>25 cu.ft/ cycle</td>
</tr>
<tr>
<td>Cost</td>
<td>NA</td>
</tr>
<tr>
<td>Limitation of Waste</td>
<td>All except anatomical and cytotoxic waste</td>
</tr>
<tr>
<td>Acceptable Load (Utilizable volume)</td>
<td>25 cu.ft (130 Kgs)</td>
</tr>
<tr>
<td>Volume Reduction</td>
<td>70%</td>
</tr>
<tr>
<td>Physical appearance of treated waste</td>
<td>Recognizable</td>
</tr>
<tr>
<td>Cost /Kg</td>
<td>Rs 2.50 (as per the technology provider)</td>
</tr>
</tbody>
</table>
The Andhra Pradesh Pollution Control Board took a forward-looking decision that no on-site incinerators will be allowed in health care institutions throughout the state. This move encouraged common waste treatment facilities in the state.

Hyderabad was the first city in the country to have a centralized facility for bio-medical waste. Two facilities, GJ Multiclave India Pvt Ltd and Medicare Incin Pvt Ltd, are operational in the city covering approximately 20,000 beds in the twin cities of Hyderabad and Secunderabad.

In addition to transport, treatment and disposal, both the facilities offer free training and consumables like bags at a nominal rate.

The facility handles waste from approximately 10,000 beds.

**Bio-medical waste management system**

The facility receives approximately 700 kgs of incinerable waste every day. The incinerator of 100 kg/hr capacity runs for around 10-12 hours a day to handle this waste. The ash is sent to a landfill.

The facility receives 30 kgs of autoclavable waste in a day. The autoclaved waste is shredded and sorted according to the kind of plastics and these shredded granules are finally sold to the plastic recycling industry.

**Sharps management**

The facility receives around 30kgs of metal sharps waste in two months. The sharps after being autoclaved are put in a 1.5-ft x 1.5 ft x 1.5 ft one bunker. The top of the bunker is then sealed with cement and sent to the landfill. One such bunker is sent to the landfill site every month. These cemented bunkers cost around Rs 150/- (3 US$).

**Other treatment technologies available at the facility**

- Incinerator: 100 kg/hr
- Autoclave: 120 lt/cycle
- Shredder
- Needle bunker: For final disposal of sharps
- Transportation: 3 covered mini-trucks
Incinerator installed at Centralized Facility Medi Care Incin Pvt Ltd, Hyderabad

Shredder installed at Centralized Facility Medi Care Incin Pvt Ltd, Hyderabad

Autoclave installed at Centralized Facility Medi Care Incin Pvt Ltd, Hyderabad

Effluent treatment plant, Centralized Facility Medi Care Incin Pvt Ltd, Hyderabad
4.11 Centralized Facility, GJ Multiclave Pvt. Ltd., Hyderabad.

The facility handles waste from approximately 10,000 beds.

**Bio-medical waste management system**

The facility incinerates around 1.2 tons of waste each day. The ash from the incinerator is sent to a secured landfill for final disposal. Autoclavable waste reaching the facility is around 250-300 Kgs each day. The autoclaved waste is segregated and shredded according to the plastic types before handing over to a recycler.

**Sharps management**

The facility receives approximately 80-90 Kgs of metal sharps waste monthly. After being autoclaved and shredded the sharps are encapsulated in 4ft x 2ft x 1.5 ft cement bunkers and once these are 3/4th full, they are covered with a cement slab. These bunkers are either sent to a secured landfill or retained to serve as benches. The facility had initially encapsulated the sharps into brick-size structures that were used for raising the height of the boundary wall of the facility. The cost of each bunker is approximately Rs. 450/- (excluding the cost of labour and cement for slab covering).

**Other treatment technologies available at the facility**

- Incinerator: 100kg/hr
- Microwave: 60 ltrs/cycle (non-functional)
- Autoclave: 120 ltrs/cycle
- Shredder
- Effluent Treatment Plant
- Needle bunker for Sharps
- Transportation: 3 Covered Mini Trucks (designated chambers for each waste type).
4.12. Sub-Divisional Hospital, District Diamond Harbour, Kolkata

West Bengal Health Systems Development Project, Kolkata

The West Bengal Health Systems Development Project under the Department of Health and Family Welfare, Govt. of West Bengal covers 120 health care institutions. The World Bank project aims at developing proper implementation of waste management in the entire State. The project includes district and sub-divisional hospitals.

Bio-medical waste management

The waste management practices adopted in all the project hospitals were similar and were based on the guidelines provided by the state health department.

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Colour code/container</th>
<th>Treatment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious (pathological tissues,</td>
<td>Yellow</td>
<td>Deep burial</td>
</tr>
<tr>
<td>cotton and gauze pieces)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infectious plastic (syringes, tubes,</td>
<td>Twin-bin and later</td>
<td>Chemical disinfection, autoclaving/Micro waving</td>
</tr>
<tr>
<td>gloves, blood and urine bags,</td>
<td>transferred to red</td>
<td></td>
</tr>
<tr>
<td>culture plates)</td>
<td>colour containers</td>
<td></td>
</tr>
<tr>
<td>Sharps: metal and glass</td>
<td>Puncture proof</td>
<td>Metal sharps are mutilated, chemical by disinfected and</td>
</tr>
<tr>
<td></td>
<td>containers (Blue)</td>
<td>placed in the sharps pit</td>
</tr>
<tr>
<td>General waste</td>
<td>Black</td>
<td>No treatment, as this category of waste is</td>
</tr>
<tr>
<td></td>
<td></td>
<td>considered non-infectious.</td>
</tr>
</tbody>
</table>

Table 13: Waste management system in West Bengal Health Systems Development Project, Kolkata

Autoclave and shredder installed at Multiclave Pvt. Ltd., Hyderabad
Sharps management

The guidelines specify that all sharps should be placed in twin-bins with the inner sieved bin containing bleach solution (10gm bleach in 1 litre water) for on-site disinfection. Needle cutter/destroyers have been provided at each nursing station for cutting the needles and the syringes. The disinfected sharps and syringes are then placed in a cardboard container and covered with a blue polythene bag and sent for final disposal along with other plastic waste. These bags are then subjected to treatment in the autoclave/microwave in the health care units equipped with these technologies and then sent for land filling.

The state uses both disposable and glass syringes in their hospitals. Disposable syringes are used mainly in the laboratory and immunization units whereas glass syringes are mainly used in the other areas of the hospitals.

For final waste disposal, secure deep burial pits are suggested in the guidelines.

Two health care institutions using alternative technologies for treatment of sharps were selected for the study.

Sub-Divisional Hospital, District Diamond Harbour, Kolkata

This is a 125-bedded general hospital located in a sub-urban area of Kolkata catering to patients from different sections of the population. The occupancy of the hospital is mostly above 100%. The different facilities provided in the hospital include blood bank, operation theatre, laboratory, OPD and emergency.

Bio-medical waste management practices

Different waste collection containers for infectious plastics and swabs, sharps, non-infectious plastics and general waste were provided at each nursing station. The infectious and general waste bins were lined with red and black bags respectively. The waste is carried from the point of generation to the final disposal site in specific colour trolleys by a dedicated housekeeping staff. A 60-lt microwave is installed in the hospital to disinfect the plastic waste. Pathological waste is collected in yellow bags and sent for deep burial.

Training about the subject has been imparted to all health care workers in the hospital and posters in regional language have been placed at different points of waste generation. Outside agencies like the Environment Wing of the Tata Consultancy Services have been hired to conduct training and monitoring of the waste management system in the hospital.

Sharps management

Sharps are first subjected, at each point of generation to mutilation by using needle destroyers/cutters. Later, the sharps waste, mainly comprising of cut syringes and needles are placed in a twin-bin with inner sieved bin containing 1% bleach solution. Each unit has a standby cutter in case of non-availability/non-functioning of the other. The hospital prefers needle cutters to destroyers because they are mechanically operated and do not require electricity.
Glass syringes with disposable needles are widely used in the hospitals. The needles are removed manually and disinfected before final disposal while the glass syringes are boiled and sterilized for further use.

**Final disposal**

The sharps are collected in puncture-resistant containers (cardboard boxes) once a day placed in red bags and carried in red trolleys with other plastic waste including disinfected syringes to the final disposal site. The plastic waste is subjected to microwaving while the metal sharps are sent for deep burial to the corporation site.

Protective clothing and gear have been provided to the microwave operator and the waste handlers collecting waste in the hospital. Tetanus injections are administered in case of any injury.

**Table 14: Description of the Microwave, Sub-Divisional Hospital, District Diamond Harbour, Kolkata**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>60lts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Rs.26.36 lacs</td>
</tr>
<tr>
<td>Limitation of Waste</td>
<td>All except anatomical and cytotoxic waste and large volume of metals</td>
</tr>
<tr>
<td>Acceptable Load (Utilizable volume)</td>
<td>15 Kgs (30 lts)</td>
</tr>
<tr>
<td>Volume Reduction</td>
<td>15%</td>
</tr>
<tr>
<td>Physical appearance of treated waste</td>
<td>Recognizable</td>
</tr>
<tr>
<td>Cost /Kg</td>
<td>Rs.30/kg</td>
</tr>
</tbody>
</table>
4.13 Jawaharlal Nehru Memorial State General Hospital, District Kalyani, West Bengal

This is a 550-bedded district-level, general hospital providing different facilities like blood bank, laboratories, radiology, operation theatre, ICU and wards. The hospital is the biggest in the district and caters to a vast population.

The waste management system followed is similar to the Sub-Divisional Hospital, Diamond Harbour. The hospital has installed an autoclave for the treatment of infectious waste (except pathological tissues). All the disposable syringes and sharps are autoclaved after being treated with 1% sodium hypochlorite solution, at the point of generation. The sharps are mutilated with needle destroyers. The autoclaved waste is disposed in specially designated landfills for medical waste in the corporation landfill site. Protective clothing has been provided to the autoclave operator and the waste handlers in the hospital. Tetanus injections are provided in case of any injury.

<table>
<thead>
<tr>
<th>Description of Autoclave at Jawaharlal Nehru Memorial State General Hospital, District Kalyani, West Bengal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
</tr>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>Limitation of Waste</td>
</tr>
<tr>
<td>Acceptable Load (Utilizable volume)</td>
</tr>
<tr>
<td>Volume Reduction</td>
</tr>
<tr>
<td>Physical appearance of treated waste</td>
</tr>
<tr>
<td>Cost /Kg</td>
</tr>
</tbody>
</table>

Final disposal

Two pits of 10 ft x 12 ft x 12 feet were constructed in the municipal landfill site for disposal of infectious, yellow bag waste. The pits were lined with thick plastic sheets and there is a pipe to remove the leachate. The institution earlier constructed a similar pit, but due to floods during the monsoon, it was destroyed.

The hospital plans to share their autoclave and the deep burial pit as a centralized facility for the nursing homes and clinics located near the hospital.
Sharps have been recognized as one of the most dangerous categories of the waste streams generated by health care facility. The problem is magnified as there is little or no occupational safety concerns in India, inappropriate waste treatment equipment and lack of training and awareness. Sharps management thus plays a vital role in the overall management of medical waste.

For the study, various non-burn technologies used for sharps treatment were valuated based on the technical considerations such as utilities, maintenance, economics and ease of operation, training as well as occupational safety needs. This chapter has been divided into different subheads based on the kind of activity from the point of generation to the final disposal of sharps.

5.1. Waste management within the health care facility

(1) Pattern of sharps generation

The quantity of sharps generation varies from one point to the other based on the kind of treatment being provided by the unit. Areas where large volumes of sharps waste are generated include laboratories, immunization centres and intensive care units. These varying quantities of sharps does not change the methods used for waste storage and treatment. The only difference noticed was in the waste collection pattern. It was seen that when the workload is high in certain units the staff would accumulate the sharps and destroy them in batches. In normal course, however, the sharps were destroyed and treated at the time of generation. The reasons could be work pressure, relaxed attitude of the health care workers and the lack of training.

The types of syringes used at different points of generation varied in different health care institutions. In most places, plastic disposable syringes were used, though in certain places glass syringes were also being used. While glass syringes were used in areas where the workload was less, disposable syringes were used in high workload areas. The usage pattern depended on availability of syringes, the kind of treatment procedure and, finally, hospital budgets and policies.
Only one unit, where UNICEF had supplied AD syringes for measles campaign, was using them for complete immunization programmes while in other units disposable syringes were being used.

(2) Sharps management at the point of generation

To ensure proper management of sharps it is important to contain the sharps in secure, puncture-resistant containers and to provide proper equipment for mutilation and disinfection at the point of generation. Collection and storage of sharps at the point of waste generation varied in the health care institutions selected for the study (as described in the chapter on success stories).

As perceived by the health care workers, sharps should be contained at the point of generation in separate puncture-resistant containers. This is important as the proper containment of sharps reduces the chances of sharps injuries and the chances of spread of infections.

The containers used for storing sharps were made of thick cardboard, plastic or metal. In the present study it was found that these containers were either covered or uncovered and placed at the nursing stations close to the injection table. The reason for using these containers was that they are puncture-resistant and sharps do not stick out of them at the time of collection. Health care institutions should eliminate the use of uncovered containers, as there is a high risk of needle-stick injuries in case of a spill.

Containment and mutilation of sharps was either done immediately after use or at the end of the session, in batches. During batch processing, the sharps were stored in kidney trays or inserted in to a piece of thermocol sponge. Later, these were mutilated by needle destroyers/cutters and then disposed into puncture-resistant containers.

The process of batch processing needs to be discouraged as the health care workers are constantly exposed to the danger of needle-stick injury from untreated sharps. Simple electric/mechanical devices and containers should be placed at each injection table to make it convenient for the health care workers to dispose sharps at the point of generation.

Disinfection of the sharps was carried out either at the point of generation or centrally and then sent for final disposal. The health care workers felt it was important to disinfect the sharps in the health care institution before it was carried for final disposal because of the fear of reuse and chances of spread of infection.

Disinfection of sharps in the health care institutions was carried out by chemical disinfection or the use of alternative technologies like autoclaving and microwaving. Chemical disinfection of waste, including sharps, in the health care institutions is carried out by sodium hypochlorite solution or bleach, which is a proven disinfectant and is also recommended in the Bio-Medical Waste Rules.
5.2 Sharps collection and transportation

Sharps should be transported from the point of generation to the final disposal site in secure, closed puncture-proof containers to ensure the safety of the health care worker and the community at large.

Waste handlers are exposed to prick-injury from sharps especially during their collection and transportation. As per the health care workers, they face a high risk of injury while transferring sharps at the point of generation to larger containers/bags for final disposal within a health setting. The chance of the injury is mainly while

Table 16: Comparative table collection and transportation of sharps

<table>
<thead>
<tr>
<th>Units</th>
<th>Mode of collection/storage</th>
<th>Mode of transportation</th>
<th>Protective gear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lion’s Hospital</td>
<td>Bread box</td>
<td>Open plastic bucket</td>
<td>Gloves, Boots</td>
</tr>
<tr>
<td>Holy Family Hospital</td>
<td>Bread box</td>
<td>Open plastic bucket</td>
<td>Gloves, Boots</td>
</tr>
<tr>
<td>St. Stephen’s Hospital</td>
<td>Puncture-resistant jars</td>
<td>Open plastic bucket</td>
<td>Gloves, Boots, Aprons</td>
</tr>
<tr>
<td>Sir Ganga Ram Hospital</td>
<td>Bread box</td>
<td>Open plastic bucket</td>
<td>Gloves, Boots</td>
</tr>
<tr>
<td>Dr. Ram Manohar Lohia Hospital</td>
<td>Puncture-resistant jars</td>
<td>Puncture-resistant jars are carried to the final disposal site</td>
<td>Gloves, Boots</td>
</tr>
<tr>
<td>M.S. Ramaiah Medical College</td>
<td>Small plastic tubs</td>
<td>Open Buckets</td>
<td>Gloves, Boots, Apron</td>
</tr>
<tr>
<td>Air Force Command Hospital</td>
<td>Pearlpet (Poly-Propylene) Jars</td>
<td>Open plastic bucket</td>
<td>Gloves, Boots, Face shields and Aprons</td>
</tr>
<tr>
<td>Sundaram Medical Foundation</td>
<td>Closed twin-bins</td>
<td>Closed Bins</td>
<td>Gloves, Boots, Face shields</td>
</tr>
<tr>
<td>Tata Memorial Hospital</td>
<td>Pearlpet (Poly-Propylene) Jars</td>
<td>Pearlpet jars are carried to the final disposal site</td>
<td>Gloves, Boots</td>
</tr>
<tr>
<td>Medici Care Incin Pvt Ltd, Centralized Facility</td>
<td>Closed pearlpet jars</td>
<td>Closed pearlpet jars</td>
<td>Gloves, Boots</td>
</tr>
<tr>
<td>Multiclav Pvt Ltd, Centralized Facility</td>
<td>Closed pearlpet jars</td>
<td>Closed pearlpet jars</td>
<td>Gloves, Boots</td>
</tr>
<tr>
<td>Diamond Harbour Hospital</td>
<td>Small plastic tubs</td>
<td>Cardboard boxes wrapped in red polybags</td>
<td>Gloves, Boots, Apron</td>
</tr>
<tr>
<td>Jawaharlal Nehru Memorial State General Hospital</td>
<td>Small plastic tubs</td>
<td>Cardboard boxes wrapped in red polybags</td>
<td>Gloves, Boots, Apron</td>
</tr>
</tbody>
</table>
emptying the sharps into bags, which are neither secure nor puncture-resistant. The needles pierce out of the bags, thus raising a danger to the health care workers.

In the health care institutions studied, sharps were collected in plastic buckets/bins, which were either covered or uncovered as shown in the Table 16.

Thus, it can be stated that to ensure proper sharps collection and transportation, the health care workers should be provided with protective gear and vaccination along with secure, puncture-resistant containers for collection and transportation. Mitigation methods in case of any spill should also be explained to the waste collectors to ensure their safety.

5.3 Treatment of sharps waste

In the health care facilities covered in the study, needle removers (destroyer/cutter) devices were widely used to mutilate the sharps at the point of generation and for removing needles from used syringes.

The function of these devices is to destroy/cut the needle and the tip of the syringes by an electric arc or by mechanical blades and safely contain them. This helps in reducing the volume of sharps from injections and ensuring that the entire injection unit is mutilated and cannot be reused. The needle remover is a comprehensive device for effectively managing sharps and has been analyzed by the set of indicators prepared for the study.

Availability and acceptability

These devices are manufactured and are easily available in the country. They are acceptable by the health care workers as they decrease the chance of spread of infection and the quantity of sharps waste requiring special containment and treatment. These machines are stand alone models and are operated either electrically or mechanically. They are easy to use and operate and the health care workers require little or no training. Electric needle destroyers were preferred compared to mechanical ones as they ‘blunt’ the tip of the needles and also cut the tip of the syringes. The disadvantage with the device was that it was electronically operated and required regular maintenance.

The plastic syringes treated by these devices are suitable for material recovery after disinfection though the needles are not accepted by the material recovery industry.

Access

Needle destroyers are generally provided at each nursing station. But due to the need of an electric socket, it becomes a stationary device and is not handy to use. As the machines get out of order very frequently some units have a standby machine in each nursing station. In other units where standby machines are not provided the staff can carry the sharps to another nursing station for destruction but this is not practiced in most of the cases.
Sustainability

The estimated life of the equipment varies between 1-4 years based on the maintenance and handling procedures adopted by the units. Monthly cleansing of the equipment is important to ensure proper functioning for a longer duration, as the most common complaint is that it does not last for more than a couple of months. The reasons for frequent breakdown are the non-functional electric arcs and blocked machine. Thus, regular maintenance of the device is important.

The cost of the equipment varies from a few hundred rupees to a couple of thousand rupees. The price also varies with the type of technology used. Mechanical devices with a simple cutter are much cheaper than the electric destroyers.

Table 17: Cost comparison between different needle burners/cutters

<table>
<thead>
<tr>
<th>Equipment description</th>
<th>Cost (Rs.) (based on the information provided by the hospitals)</th>
<th>Average life of the equipment (based on the information provided by the hospitals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needle cutter (mechanical cutters)</td>
<td>200-500</td>
<td>1 year</td>
</tr>
<tr>
<td>Needle destroyer (electrically operated needle melter with or without a mechanical cutter)</td>
<td>1500-5000</td>
<td>1-3 years</td>
</tr>
</tbody>
</table>

Occupational safety

According to the health care workers, the devices are safe to use, but the hazard they pose is with the container storing the cut/burnt tips of sharps and syringes. These containers overflow very frequently with needles sticking out, thus posing a serious health risk to the health care workers handling these containers. Containers should be safe, easy to operate and clean. They must be secure; tipping/dropping of the container should be avoided. Transparent containers should be used so that the health care workers empty them regularly to ensure their own safety. The device should also be resistant to water and detergents to ensure that it last long. Initially, users complain of aerosol emissions and sparks when using the device but later they get used to the machine. The health care workers have been advised to use protective gear while handling these devices for their safety.

Regulatory acceptance

The Bio-Medical Waste (Management & Handling) Rules, 1998, make it mandatory to mutilate the sharps before final disposal and as these devices are used for the same they are suitable devices for mutilation of the sharps at the point of generation. The Government however, has not provided any comprehensive guidelines and standards for these devices.
5.4 Evaluation of waste treatment technologies

(1) Autoclaving

Autoclaving (steam sterilization) is a low-heat process and is designed to bring steam into direct contact with the waste for a sufficient duration to disinfect it. The three basic types of steam autoclave systems are: gravity, pre-vacuum and retort systems. In gravity type autoclaves pressure alone is used to evacuate air from the treatment chamber. In Pre-vacuum type, vacuum is used to evacuate air from the chamber while the retort type comprises of large volume treatment chambers designed for much higher steam temperatures and pressures.

The waste cycle time varies from 30-90 minutes depending on the temperature and pressure of the machine.

Table 18: Comparative table on costs of autoclaving waste

<table>
<thead>
<tr>
<th>Units</th>
<th>Beds</th>
<th>Quantity of waste autoclaved</th>
<th>Capacity Per cycle</th>
<th>Waste treated</th>
<th>Cost of treatment /Kg in USD</th>
<th>Capital Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundaram Medical Foundation</td>
<td>125</td>
<td>12 Kgs/day</td>
<td>25 lit</td>
<td>All types of waste except cytotoxic and pathological tissues</td>
<td>0.1</td>
<td>400</td>
</tr>
<tr>
<td>Kalyani General Hospital</td>
<td>550</td>
<td>187 Kgs/day</td>
<td>250 lit</td>
<td>Infectious plastics and sharps</td>
<td>0.1</td>
<td>40,000</td>
</tr>
<tr>
<td>Medi Care, Hyderabad (Centralized facility)</td>
<td>10,000</td>
<td>30 Kgs/day</td>
<td>120 lit</td>
<td>-do-</td>
<td>NA</td>
<td>600</td>
</tr>
<tr>
<td>Multiclave Hyderabad (Centralized facility)</td>
<td>10,000</td>
<td>250-300 Kgs/day</td>
<td>120 lit</td>
<td>-do-</td>
<td>NA</td>
<td>600</td>
</tr>
</tbody>
</table>

Availability

Waste autoclaves are readily available in the market. Presently, more than 24 dedicated waste autoclaves have been installed in the country, which cater to individual hospitals as well as centralized facilities. With growing awareness on biomedical waste management, a large number of vendors are now manufacturing and supplying autoclaves locally. The autoclaves are available in different sizes and capacities right from a small laboratory model (5 lit capacity) to as large as 2000 litres capacity models.
Acceptance

Autoclaves are widely accepted by health care facilities as they have been traditionally used for sterilizing reusable instruments in hospitals. Moreover, people find them safe, easy to operate and cost effective.

The waste is recognizable after treatment and requires either pre- or post-shredding. The treated syringes and needles are also acceptable for reprocessing by the plastic reprocessing units and the metal sharps, including needles, are also accepted for smelting as they are disinfected.

Access

In hospitals waste autoclaves are located near the final disposal area. Underutilized treatment capacity can be utilized by other facilities, regionally or locally.

Sustainability

Health care facilities feel that autoclaves are cost effective methods of treating medical waste. The initial cost of installation is less compared to the burn technologies ranging between $ 600 to $40,000 USD. Running an autoclave is also economically viable as the main requirements for its operation are electricity and steam and no costly pollution abatement equipment is required. The cost of treatment/ kg waste was around $0.1USD/Kg, including the cost of manpower, maintenance, the cost of electricity and also the cost of shredding.

It is important for autoclave operators to be trained. This would enable them to operate the machine, meet the required norms and rectify any problem in case of an emergency.

Autoclaves installed in the health care facilities covered in the study have been in working condition since their installation, with regular maintenance and repair.

Thus, for ensuring sustainability of the system, it is important to impart training to the operators, and to ensure regular maintenance and monitoring of the system.

Occupational safety

Operators using various machines have been provided with different protective gear like face shield, gloves, boots and apron along with vaccination. During loading and unloading of the waste they wear the protective gear to ensure their safety.

Regulatory acceptance

Autoclaving has been approved by the pollution control board as one of the alternative treatment technologies for treating all medical waste except cytotoxic waste and pathological tissues.
(2) Advanced Autoclave: Hydroclave™ and Bio-clave

These are advanced autoclaves in which heating is indirect, with steam being provided in the outer jacket of a double-chambered container. The waste is internally agitated and fragmented by blades provided in the inner chamber. The moisture content in the waste turns into steam thus creating the necessary pressure. The duration of the treatment cycles is 15 – 30 minutes depending on the temperature and pressure.

Table 19: Comparative table of costs of advanced autoclaving of waste

<table>
<thead>
<tr>
<th>Units</th>
<th>Beds</th>
<th>Quantity of waste hydroclaved</th>
<th>Capacity per cycle</th>
<th>Waste treated</th>
<th>Cost of treatment Kg (USD)</th>
<th>Capital Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tata Memorial Hospital (Hydroclave™)</td>
<td>450</td>
<td>300 kg/day (113kg/cycle)</td>
<td>25 cu. feet</td>
<td>All types of waste except cytotoxic and pathological tissues</td>
<td>0.05</td>
<td>80,000</td>
</tr>
<tr>
<td>Air Force Command Hospital (Bio-clave)</td>
<td>830</td>
<td>170Kgs/day</td>
<td>250 lit.</td>
<td>Food waste</td>
<td>0.05</td>
<td>62,000</td>
</tr>
</tbody>
</table>

Availability

Advanced autoclaves are locally manufactured and are readily available in the market. Presently, four units of such dedicated advanced autoclaves have been installed in the country, at individual hospitals as well as a centralized facility.

Acceptance

Health care facilities are now accepting advanced autoclaves as the basic functioning is similar to autoclaves and the waste is dry and are drastically reduced by weight and volume (around 70%). The other reasons are that the facility operators find it safe and easy to operate. Also, it is cost effective and ensures sterilization by killing the spore along with the microbes. The validity of the technology as per the Rules is checked by the spore strip test using Bacillus subtilis.

In this method, the waste is shredded simultaneously with disinfection. Therefore, the treated waste is of mixed type. As the waste is mixed, the treated syringes and needles though acceptable for reprocessing by the plastic reprocessing units, would sell at a lower price. One of the facilities was using the machine for treated syringes and needles while the other used this machine for treating their food waste and chemically disinfected their sharps.

Access

In the present study, the advanced autoclaves were located near the final disposal site in 21 hospitals. The treatment technology used at each of these hospitals presently
could not be accessed by other facilities. However, depending on the capacity of the machine (treatment facilities with over-capacity can be shared by other institutions) and its availability, regionally or locally, it can be shared by other institutions or used as a centralized facility.

**Sustainability**

The health care facilities find advanced autoclaves to be cost effective methods of treating medical waste. The initial cost of installation was between $62,000 to $80,000 USD. According to the information provided by the manufacturers, the cost of running the equipment is around $0.05USD/Kg excluding the cost of shredding. This cost does not include the cost of manpower and maintenance.

The low running cost, according to the manufacturers, is due to the reuse of the steam generated in the jacket for more than one cycle.

The advanced autoclaves installed in the health care facilities in the present study have been in working condition since they were installed (around 3 years) with regular maintenance and repair.

There are not many such machines in the world. Based on the information provided in the present study, similar measures as for autoclaves need to be taken to ensure the longevity of these machines.

**Occupational safety**

The equipment operators have been provided with different protective gear, used while loading and unloading the waste as well as vaccination to ensure their safety.

**Regulatory acceptance**

Autoclaves have been approved by the pollution control board for treating all kinds of bio-medical waste except cytotoxic waste and pathological tissues. Presently, one of the manufacturers using the trademark, Hydroclave™, has been given approval by the pollution control board.

**3) Microwave**

Microwave disinfection is essentially a steam-based process, since disinfection occurs through the action of moist heat and steam generated by microwave energy. In the microwave magnetrons are used to convert high wave electrical energy into microwave energy, which is then transmitted into a metal channel called a wave-guide that directs the energy into the chamber. Unlike other thermal treatment systems which heat wastes externally, microwave heating occurs inside the waste material.

**Availability**

As compared with other alternative-technology dedicated waste treatment, microwaves are still being mostly imported. The number of installations is also limited to individual hospitals.
Acceptance

The health care facilities accept microwaves, as the basic functioning is similar to the household microwave. There is, however, apprehension regarding treating metal sharps by microwave technology due to the fear of sparks created during the treating process. The available literature suggests that sharps can be readily treated by this method but it is not recommended for too large or hard metals such as steel plates that are too hard to go through the shredder and not because they cannot be treated. (Non-Incineration Medical Waste Treatment Technology, HCWH Aug 2001). Due to the apprehension of treating metal sharps, presently only plastics are being treated in microwaves.

Access

Microwaves were located near the final disposal site in two health care institutions while in one institution it was located at the point of generation (dialysis unit) and used for treating infectious plastic waste. The treatment technology used at each of these facilities could not be accessed by other facilities. But, depending on the capacity of the machine (treatment facilities with over-capacity can be shared by other facilities) and its availability regionally or locally, these facilities can be shared by other institutions or used as centralized facilities.

Sustainability

According to the health care facilities, microwaving is an expensive waste treatment technology. The initial cost of installation of these machines was between $13,000 and $70,000 USD. According to the information provided by one of the facility operators, the running cost of the equipment is around $ 0.75 USD/ Kg. The high cost of running can be attributed to the high electricity consumption by the machine. This cost of treatment includes the cost of manpower and maintenance along with the cost of electricity.

Training is essential for operators and this should include management of any kind of microwave leakages.

Table 20: Comparative table of costs of microwaving waste

<table>
<thead>
<tr>
<th>Units</th>
<th>Beds</th>
<th>Quantity of waste microwaved</th>
<th>Capacity/ cycle</th>
<th>Waste treated</th>
<th>Cost of treatment /Kg (USD)</th>
<th>Capital Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Ram Manohar Lohia Hospital</td>
<td>937</td>
<td>NA</td>
<td>60 lts</td>
<td>Infectious plastics</td>
<td>NA</td>
<td>70,000</td>
</tr>
<tr>
<td>Diamond Harbour, Sub-Divisional Hospital</td>
<td>125</td>
<td>43 Kgs/day</td>
<td>60 lts</td>
<td>Infectious plastics</td>
<td>0.75</td>
<td>70,000</td>
</tr>
</tbody>
</table>
Due to its high running cost and also because it cannot treat all kinds of waste, the number of microwave installations in the country is limited.

**Occupational safety**

The operators have been provided with different protective gears along with vaccination.

The health care workers should regularly monitor the area where the microwave is located to detect any leakage. Care should also be taken while treating large quantities of metal sharps, as there is a chance of a spark or fire.

The syringes, after being treated, are safe. Shredding ensures that the shredded plastic waste cannot be reused.

**Regulatory acceptance**

Microwaves have been approved by the pollution control board as one of the alternative treatment technologies for all kinds of bio-medical waste except cytotoxic waste and pathological tissues.

**5.5 Options for final disposal**

**(1) Encapsulation**

According to WHO (1999), encapsulation is considered the easiest method for the safe disposal of sharps. Sharps are placed in puncture-proof and leak-proof containers, such as high-density polyethylene boxes, metallic drums, or barrels. When a container is three-quarters full, it is sealed with materials such as cement mortar, plastic foam, plaster of Paris, clay or any immobilizing material. This sealed container can be sent for land filling, stored, or buried.

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Quantity of waste encapsulated</th>
<th>Cost (Rs.)</th>
<th>Reasons for selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holy Family Hospital</td>
<td>35 tins (1 tin = 20lts Needles)</td>
<td>NA</td>
<td>As a final disposal option. They were deep buried in the foundation of the new building.</td>
</tr>
<tr>
<td>GJ Multicleave, Hyderabad (centralized facility)</td>
<td>One cement bunker (4ft<em>2ft</em>2ft)= 80-90 kg sharps waste/ 2 months</td>
<td>450/ bunker</td>
<td>As a final disposal option, sent to secured landfill. A few bunkers were used as benches and also used to line the boundary wall</td>
</tr>
<tr>
<td>Medi Care Incin, Hyderabad (centralized facility)</td>
<td>One cement bunker (1.5 cu ft)= 30 Kgs/2 month</td>
<td>150/bunker</td>
<td>As a final disposal / sent to secured landfill</td>
</tr>
</tbody>
</table>

Table 21: Comparative table of costs of waste encapsulation
Availability and acceptance

Encapsulation is an option which requires no major investments and is easy to adopt. This method was therefore practiced as one of the final methods for sharps disposal by the health care facilities/centralized facilities. The basic requirements for encapsulation are a container to store the disinfected sharps that can be made of concrete, plastic or metal and an immobilizing agent like cement or plaster of Paris.

Access

Sharps encapsulated in sealed containers can be deep-buried within the institutions or institutions can access facilities of other institutions or the encapsulated sharps can be sent to a secured landfill. In the present study, individual health care facilities deep-buried the containers in their own compound while centralized facilities used secured landfills for the same. As secured landfill sites were not available in other areas and institutions did not have adequate land this was not a very common practice among health care institutions.

Sustainability

This is an economically viable option not requiring much initial or recurring investment. The training required is also very minimal, thus making it convenient for the institutions. As the final disposal requires land, this option was seen as a major hurdle in sustaining the system for long.

Occupational safety

As the method ensures minimal handling of sharps by the health care workers and they are inaccessible to the community at large the method is largely safe.

Regulatory acceptance

This method of final disposal is not directly mentioned in the rules. The rules specify secured land filling of mutilated sharps.

(2) Sharps pit

This option is one of the modes for final disposal of sharps involving burying of sharps as described by WHO (1999) in deep pits. These pits are either made up of clay/brick lining/cement with a lining at the bottom to ensure no leaching into the soil. The pit is covered from the top by concrete slabs. Safe burying inside premises in hospital may be the only rational option available at times. The health care facilities have built these safe pits as an option for final disposal of sharps.

Availability and acceptance

This method is widely used and accepted as the final disposal option by different health care facilities throughout the country. The reasons are that this is a locally available option, can be adopted on site and is one of the final disposal options recommended by different agencies including the Government and WHO.
With growing urbanization, the availability of land for setting up a sharps pit is seen as a constraint by health care facilities. As seen in the study, the sharps pit gets full earlier than their projected life. Thus, the institutions need additional pits for disposal of sharps. The reasons for early filling of the pits can be due to uneven distribution of sharps and accumulation of sharps near the opening of the pit. The other reason could be mixed waste being sent to the pit instead of only metal sharps. The Hospitals see the sharps pit only as a short-term solution for the final disposal of sharps because of its limited utility.

### Access

Sharps pits are constructed both on-site and off-site. The on-site facilities are constructed within the health care facilities. Keeping in mind disposal of in-house sharps, such institutions therefore are not able to take sharps of other institutions. While the off-site facilities are constructed to cater to more than one health care facility, they act as a central collection unit. For either type of facility it is important that access to the sharps pit is restricted, the pit is always locked and is located in an area to which the public and hospital staff have minimal accessibility. Limited access to the sharps pit is important because of the chances of scavenging and reuse of sharps.

### Sustainability

This is an economically viable option requiring not much initial or recurring investment. The cost of construction of a sharps pit varies from 10 USD (Rs. 500) to

<table>
<thead>
<tr>
<th>Units</th>
<th>Beds in the unit</th>
<th>Location of the pit</th>
<th>Sizes (Cu ft)</th>
<th>Actual life (years)</th>
<th>Sharps per day</th>
<th>Reason for selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lion’s Hospital</td>
<td>64</td>
<td>On-site</td>
<td>3<em>3</em>3</td>
<td>4:4</td>
<td>100 gms</td>
<td>Recommended in National Guidelines and by WHO</td>
</tr>
<tr>
<td>St. Stephen’s</td>
<td>590</td>
<td>On-site</td>
<td>7<em>4</em>4</td>
<td>4:3</td>
<td>5 lt</td>
<td>-do-</td>
</tr>
<tr>
<td>Sir Ganga Ram</td>
<td>500</td>
<td>On-site</td>
<td>3<em>3</em>5</td>
<td>1:1</td>
<td>6 Kg</td>
<td>-do-</td>
</tr>
<tr>
<td>Dr. Ram Manohar Lohia</td>
<td>937</td>
<td>On-Site</td>
<td>12<em>6.3</em>4.3</td>
<td>2:1</td>
<td>3 Kg</td>
<td>-do-</td>
</tr>
<tr>
<td>Kalyani General Hospital</td>
<td>550</td>
<td>Off-site (common facility)</td>
<td>10<em>10</em>12</td>
<td>4:2</td>
<td>NA</td>
<td>All kinds of infectious waste</td>
</tr>
<tr>
<td>Ramaiah Medical College</td>
<td></td>
<td>Off-site</td>
<td>10<em>10</em>12</td>
<td>3:2</td>
<td>0.4 Kg</td>
<td>For secure storage of sharps</td>
</tr>
</tbody>
</table>
1000 USD (Rs. 50,000) depending on its type and size. A simple and small brick-lined pit is cheap while bigger leach-proof pits with concrete lining and rust-proof paint are more expensive.

The longevity of the pits depends on their size and the type of waste disposal into it. It has also been noticed that the kind of opening narrow or broad also influences the life of the sharps pit. In case of a small opening, the sharps are accumulated at one place near the opening and thus it gets full soon. While in those with broad openings the waste evenly spreads in the pit and it does not get full as quickly as the narrow opening. As the pits get full before their expected life they are of limited utility as the institutions do not have the required land to make new sharps pit.

As minimal training and unskilled manpower is needed to handle a sharps pit the institutions can conveniently adopt this method.

**Occupational safety**

The chances of needle-stick injuries while handling sharps is greater while emptying the sharps containers into the pit. Thus, the facility providers should use containers which are secure, puncture-proof, easy to empty and requiring minimal handling. The disinfection and mutilation of sharps at the point of generation also assures safe handling and disposing of sharps. Vaccination and proper protective gear for handlers are also helpful.

The Safety of the community is ensured by the safe containment of the sharps in the pit with no leaching in the soil. Access to the sharps can be prevented by storing them under lock and key.

**Regulatory acceptance**

The Bio-Medical Waste (Management and Handling) Rules, 1998, mention the option of deep burial for pathological tissues for cities with less than 500,000 inhabitants. The rules, however, do not mention the option of safe pit for sharps. The guidelines submitted by the committee constituted by the Ministry of Environment and Forest for the implementation of the Rules suggest a safe pit for final disposal of sharps.
# Table 23: Technology/Indicator Evaluation Matrix

(Findings are based on the perceptions of the health care workers)

<table>
<thead>
<tr>
<th>Indicator Technology</th>
<th>Availability</th>
<th>Acceptability</th>
<th>Accessibility</th>
<th>Sustainability</th>
<th>Occupational Safety</th>
<th>Regulatory Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needle destroyer/cutter</td>
<td>Easily available: many vendors and local manufacturing</td>
<td>Easy to operate for health care workers</td>
<td>Cannot be accessed by other health care facilities</td>
<td>Low initial and operating cost but frequent maintenance required.</td>
<td>Safe to the health care workers while operating and safe for handling by the community after disinfection</td>
<td>Used for mutilation of sharps at the point of generation</td>
</tr>
<tr>
<td>Autoclave</td>
<td>Many vendors and local manufacturing</td>
<td>Easy to operate, ensures disinfection and regulatory compliance, waste is acceptable for reprocessing</td>
<td>If located in a centralized facility or the capacity of the machine is large enough to be shared by other institutions</td>
<td>Medium to high capital cost, low operating cost, and regular maintenance required. Operators training essential.</td>
<td>Safe to the health care workers while operating and later the treated waste is safe for handling by the community.</td>
<td>Technology is approved by the Government</td>
</tr>
<tr>
<td>Hydroclave™</td>
<td>Couple of vendors and local manufacturing</td>
<td>Easy to operate, ensures disinfection and regulatory compliance, waste is acceptable for reprocessing</td>
<td>If located in centralized facility or the capacity of the machine is large enough to be shared by other institutions</td>
<td>Medium to high capital cost, low operating cost, and regular maintenance required. Operators training essential.</td>
<td>Safe to the health care workers while operating and later the treated waste is safe for handling by the community.</td>
<td>Technology is approved by the Government</td>
</tr>
<tr>
<td>Microwave</td>
<td>Couple of vendors and mostly imported machines</td>
<td>Easy to operate, ensures disinfection and regulatory compliance, waste is acceptable for reprocessing (metal sharps are presently not treated due to apprehension of sparks)</td>
<td>If located in centralized facility or the capacity of the machine is large enough to be shared by other institutions</td>
<td>Medium to high capital cost, high operating cost, and regular maintenance required. Operators training essential.</td>
<td>Safe to the health care workers while operating and later the treated waste is safe for handling by the community.</td>
<td>Technology is approved by the Government</td>
</tr>
<tr>
<td>Encapsulation</td>
<td>Can be done in small containers and later be disposed on the availability of space.</td>
<td>Simple technique with little investment and does not require skilled manpower</td>
<td>If available in a centralized facility, N: when individual health care facilities have one.</td>
<td>Low initial and running cost.</td>
<td>Safe to the health care workers and the community</td>
<td>Does not have a mention in the rules or the guidelines N: Land scarcity</td>
</tr>
<tr>
<td>Sharps Pit</td>
<td>Due to lack of space construction of sharps pit is a major problem</td>
<td>Simple technique with little investment and does not require skilled manpower</td>
<td>Due to lack of space presently individual health care facilities find it difficult to share with other facilities.</td>
<td>Low initial and running cost.</td>
<td>Safe to the health care workers and community. Need to ensure that the pit is leach proof</td>
<td>Does not have a mention in the Rules but guidelines mention deep burial of sharps</td>
</tr>
</tbody>
</table>
Material recovery from waste is an efficient method to manage waste. Material recovery helps in successfully recovering a substantial part of the material in a cost effective manner and also minimizes the quantum of waste to be disposed.

In the present study the material recovery potential of auto-disable ‘syringes and needles’ was addressed. Different waste pickers, sorters and recycling industry owners were interviewed to understand the needs and problems associated with material recovery of the waste stream.

Through review of literature (Recycled Plastics Manufacture and Usage Rules, 1999 and Recycling guidelines) and meetings with waste pickers of the hospitals and industry owners of Narela and Wazirpur industrial area of Delhi the material recovery potential of AD syringes was evaluated.

6.1 Plastic reprocessing

Perception of plastic reprocessing industry: Focus Group Discussions were organized with the plastic reprocessing industry to identify their needs and concerns for processing plastic waste generated from hospitals.

According to the industry, due to the concerns of infection associated with medical waste they are apprehensive in accepting plastic waste from hospitals. The industry is willing to accept waste from health care facilities if it is properly disinfected and shredded.

Industry perceptions

Discussions with the industry representatives suggested that they are willing to accept all kinds of plastics being generated from the hospitals for reprocessing. For the present study, samples of AD syringes were shown to the industry owners. The main feedback from the industry was:
(1) The AD syringes shown to them were made of different kinds of plastics.

**Recommendation of the industry:** It would be convenient and economically viable to reprocess the syringe if the entire unit was made from a single kind of plastic.

(2) The present model of fixed-needle AD syringe was difficult to reprocess.

**Recommendation of the industry:** The industry felt that the present design of the AD syringe was not easy to reprocess due to the fixed needle. If the needles are removed from the hub then it would not only be much easier for them but also the needles could be sent for reprocessing. Fixed needles would also put the industry workers at risk.

The industry highlighted the need of disinfection and mutilation of the syringes before these were handed over to them for reprocessing.

(3) The quantity of waste that can be reprocessed

**Industry response:** According to the industry, it is capable of reprocessing large quantities of plastic waste. The industry seemed positive to handle the large number of AD syringes that would be generated due to their use in the immunization programme. The rate offered by the industry for the plastic waste could range between Rs. 25-30/- per Kg.

(4) Feasibility of reprocessing

**Industry response:** Though the industry found it slightly difficult to reprocess needle fixed AD syringes, the reprocessing unit suggested it would separate plastic from needles by mixing the two in water. Due to greater density of the needles they would settle in water while the plastics would float on the surface. This principle will help in separating the metal and the plastic. The metals can later be handed over to scrap dealers for further reprocessing.

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**The Bangalore Success Story**

Around 25 million AD syringes (fixed needle) were used by the community medicine department of Ramaiah Medical College Bangalore for mass measles campaign. To assess the reprocessing of the AD syringes the department stored the syringes and handed them to a plastic reprocessing industry.

Before being sent for reprocessing, the AD syringes were chemically disinfected and the needles were manually defanged with the help of pliers. The 235 Kg of plastic generated from these syringes were converted into 8”x3”x3” rectangular boxes by the plastic reprocessing industry. The metal needles were handed over to the Indian Institute of Science, Bangalore to melt into a small block.

During this experiment with used AD syringes the authorities found it difficult to decontaminate and mutilate them. The danger of needle-stick injury and the occupational safety of the waste handler was a matter of concern to the authorities. Due to the needle fixed model syringes, the industry found it difficult to reprocess them.
6.2 Metal reprocessing

Metal sharps, especially the needles generated from the health care facilities are presently being disinfected, mutilated and finally disposed into either deep burial pits or encapsulated or handed over to a waste contractor or sent to municipal dumps or landfills. With receding resources and lack of space the health care providers find it difficult to continue with most of these options. Thus, reprocessing of metal was suggested as the best option by the health care industry.

**Smelting** This is a process of melting or fusion, especially to extract a metal from its ore. Smelting processes vary, depending on the nature of the ore and the metal involved, but they typically use a blast furnace. The same concept of smelting is used for recovering/recycling metals. In the health care industry, instruments made of stainless steel are used widely. Whether these are single-use or multiple-use instruments, the material recovery potential is well established. Meetings with authorized smelting units in Wazirpur, Delhi, revealed that the industry is willing to accept the metal sharps from hospitals especially sharps waste from injections i.e., “needles” as they are made up of high grade stainless steel.

The industry was willing to reprocess the needles only when the metal part of the needles is sent to them without the plastic hub for reprocessing, as the plastic hubs would spoil the quality of the reprocessed metal. The industry also wants the metal in large quantities, as it would only then be economically viable for them to carry the waste from the hospitals. The rate offered by the industry for the needles collected by them ranged between Rs 25-30/- per Kg. There was not much concern within the industry regarding the environmental and occupational aspects of needles.

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**Smelting of sharps by Sundaram Medical Foundation**

Smelting of metal sharps was adopted by one of the hospitals covered in the study. The hospital presently sends their sharps waste (needles) to a cast iron foundry for smelting. The sharps in the hospital are autoclaved, shredded and then packed in thick cardboard boxes lined by polythene bags. These boxes are again placed in cardboard boxes to make sure that the needles do not stick outside the containers. These containers are then sent to the foundry for smelting.

Only 10 kgs of sharps are sent to the foundry for smelting every 15 days as beyond this quantity the quality of the cast iron being manufactured by the industry would be affected. This foundry is not willing to accept waste from other health care facilities, as they are concerned about the quality of their iron. The other concern the industry had is with spread of infection through sharps waste as the foundry was not sure of the sterilization of the waste coming from other units. The benefits were not clear.

**Brief description about the foundry**

- **Source of sharps waste:** Sundaram Medical Foundation, Chennai, India
- **Quantity of sharps generated by the hospital:** 20 Kgs/ month
- **Foundry:** Brakes India Limited., Foundry division, Sholinghur (Tamil Nadu)
- **Kind of factory:** Cast Iron foundry
- **Quantity of iron processed:** 45,000 tons/annum
reprocessing. The only concern the industry had was for transportation of sharps. The industry felt that due to the danger of pricking and spread of infection through needles, the waste had to be transported in puncture-proof containers from source.

As the present solutions available for sharps disposal can not handle the huge bulk of sharps and provide short-term solutions for the sharps generated by the hospitals, this option was preferred over others. The health care workers felt that this would provide a permanent solution to the existing problem of sharps disposal and the metals could be reprocessed and utilized in a new form.

6.3 Auto-disable syringes

Unsafe injection practices increase the chances of transmission of blood-borne pathogens. Recognizing the widespread occurrence of non sterile injections in immunization programmes, WHO, UNICEF and UNFPA signed a joint statement in 1997 on the need for single use, “auto-disable” AD syringes and safety boxes to contain them in immunization campaigns. These single use syringes ensure the safety of health care workers and the community at large. The joint statement urged that by the end of 2003, all countries should use only auto-disable syringes for immunizations. Working towards that goal, all the partners decided to work towards safe administration devices and disposal units.

In this study, to examine the use and disposal of AD syringes amongst health care workers, different types of AD syringes were introduced to them. The perceived advantages and disadvantages of the AD syringes by the health care workers are as mentioned below. Their perceptions were based on the sample of syringes that were given to them for their feedback and not on actual usage of the same. The health care workers felt that real usage of the AD syringes would have enabled them to give better feedback but, as it was not in the scope of the study, syringes could not be distributed to them for actual use.

**Advantages of AD syringes as perceived by health care workers:**

1. **The syringes are easy to use**: The health care workers felt that AD syringes would be easy to use as they are single-unit devices and easy to load for specific doses, especially for given injections.

2. **Single-use syringes**: The health care workers felt that the single-use design of these syringes would ensure that the syringes couldn’t be reused. This, they felt, was a major advantage over ordinary syringes as the latter could be reused. Thus, there was the danger of spread of infections through them.

3. **Useful in rural areas**: According to health care workers, AD syringes would prove very helpful in rural settings. Presently, due to the use of glass syringes in immunization programme, the ANMs have to carry boilers to disinfect

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these syringes. They felt that with the introduction of AD syringes it would become much easier.

**Disadvantages of AD syringes as perceived by health care workers:**

1. **More expensive than normal syringes:** The health care workers felt that AD syringes were more expensive than normal syringes. They would thus be too expensive for the general public and the government hospitals.

2. **Difficult to disinfect:** As the syringes get locked after use, the health care workers felt that it was difficult to chemically disinfect them at source. Thus, there was a chance of spread of infection. This factor is important because most of the units depend on chemical disinfection autoclaves and microwaves are not available with many health care facilities. The problem of waste management would be immense especially in rural areas.

3. **Disposal of AD syringe/needle as a single unit:** The health care workers felt that disposal of AD syringes would be a problem especially with the needle-fixed models, as they pose as a single big sharp. Due to the needle-fixed model even after the needles are cut/destroyed they remain attached to the syringe. Thus, they have to be disposed as a single unit. Disposal of these units will be a potential problem, as they would occupy more space at the final disposal site compared to the present disposal syringes and detachable needles (especially for institutions using sharps pits or encapsulation techniques).

4. **Increased bulk of waste:** Presently, glass syringes are used at many places for immunization and curative purposes; with AD syringes, there would be a tremendous increase in the quantity of waste generated. The health care facilities felt that before AD syringes are introduced, the problem of their disposal should be addressed.
7

Findings of the Study and Recommendations for Future Work

7.1 Main findings of the study

(1) Point of generation

(a) Sharps are segregated at the point of generation in puncture-proof containers. Disinfection and mutilation of sharps at source was considered essential before the waste was sent outside the hospital for final disposal.

(b) Most health care workers felt that the use of simple devices like needle cutters and destroyers for mutilation of sharps were important. These devices are used in nearly 70% of the institutions covered in the study.

(c) Sharps need to be stored in puncture-resistant containers to ensure the safety of health care workers. In the present study, all the health care facilities provided puncture-resistant containers for storing sharps at the point of generation.

(d) Transportation of sharps should be in secure, closed containers. This was being followed only by one health care facility covered in the study.

(e) Health care workers should be provided with proper protective gear while handling sharps. In the present study, protective gear was provided in all health care facilities.

(f) Occupational safety issues need to be addressed by the institutions along with introducing vaccination for staff and post-prophylaxis measures. Presently, only 40% of the institutions had an accident reporting format and post-prophylaxis measures in place.

(2) Alternative treatment technologies used for sharps treatment:

(a) Chemical disinfection of infectious plastics at the point of generation or at a central location was practiced by 93% of the institutions covered in the study. There was, however, no check on the quality of the chemicals used.

(b) Autoclaving of infectious plastics and sharps waste was followed in 40% of the institutions covered in the present study. This is a cost-effective treatment technology and the waste is recognizable after treatment and thus requires post-shredding.
(c) Microwaving of infectious plastics was followed in 20% of the health care institutions while due to the apprehension of sparks, no metal sharps were treated by this method. This is an expensive treatment technology and the waste is recognizable after treatment, requiring post-shredding.

(d) Hydroclaving was used in one of the health care facilities for treated infectious plastics and metal sharps. Waste was partially recognizable after treatment and preliminary shredding was carried out during the process of treatment.

(e) The mutilated and treated waste from these methods has recycling potential.

(f) Needle cutters destroyers are infectious per se. The hospitals regularly clean the destroyers with sodium hypochlorite.

(3) Final disposal

(a) A sharps pit was used as the final disposal option in 54% of the health care institutions. Though an effective final disposal option, the hospitals felt that this was a short-term solution as the pits got filled up soon. Due to lack of space, the construction of new pits was not considered a feasible option in urban settings.

(b) Encapsulation of sharps was tried in 30% of health care facilities. This was considered as a suitable and an economically viable option but the concern again was of space/land/landfill site where, finally, the encapsulated sharps will be sent.

(4) Material reprocessing

(a) Plastic Reprocessing: After treatment, the shredded plastic from syringes is collected by the formal or informal sector for material recovery in all the health care units covered in the study. To ensure the safety of people working in the material recovery industry, the hospitals should provide disinfected and mutilated waste to the industry.

(b) Metal Reprocessing: Smelting of metals was considered as one of the final disposal options by the health care facilities. The other options available provided only a short-term solution for sharps disposal. Reprocessing of the sharps was thus considered a better solution to the present problem of sharps management. In the present study, only one health care facility smelted their metal sharps.

(5) Auto-disable syringes

(a) The concept of AD syringes was new to the health care workers and the material recovery industry.

(b) AD syringes will help in minimizing the spread of infections through medical waste, as these syringes cannot be reused.

(c) The health care workers felt that the AD syringes were expensive and it was difficult to chemically disinfect them.
(6) Policy on immunization waste management

Presently, there is no waste management policy formulated by the Ministry of Environment and Forest specific to immunization waste as this category is considered as a part of the bio-medical waste and is covered under the existing rules.

Within the existing framework, some guidelines should be laid down to ensure that immunization camps and routine immunizations do not leave unmanaged waste.

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Annex 1
Sharps Waste Management
Charts of the Surveyed Facilities

Diagram 3: Sharps waste management flow chart at Lions Hospitals, New Delhi

- **Point of sharps use (Injection unit)**
  - Needle cutter
  - Chemical disinfection (Bleach solution)
    - Needles
    - Syringes
    - Contained in puncture proof container
    - Handled over to waste contractor
  - Sharps pit/centralized facility
    - Buckets

Diagram 4: Sharps waste management flow chart in Holy Family Hospital

- **Point of sharps use (Injection unit)**
  - Needle destroyer
  - Chemical disinfection (Bleach solution)
    - Needles
    - Syringes
    - Contained in puncture proof container
    - Shredded and handed over to waste contractor
  - Encapsulation/waste contractor
    - Inserted in thermocol (In case of batch processing)
    - Bucket with sharps in a trolley
Diagram 7: Sharps waste management flow chart at Dr. Ram Manohar Lohia Hospital

- Point of sharps use (Injection unit)
- Needle destroyer
- Chemical disinfection (Bleach solution)
- Needles
- Syringes
- Contained in puncture proof container
- Microwaved/Shredded and handed over to waste contractor
- Sharps pit
- Containers in wheelbarrow

Diagram 8: Sharps waste management flow chart at Ramaiah Medical College

- Point of sharps use (Injection unit)
- Syringes and needles are manually separated
- Chemical disinfection (Bleach solution)
- Needles
- Syringes
- Contained in puncture proof container
- Handled over to a waste contractor
- Sharps pit
- Specially designed vehicle
Diagram 9: Sharps waste management flow chart at Air Force Command Hospital

- **Point of sharps use** (Injection unit) → Needle destroyer → Chemical disinfection (Bleach/Savalon® solution)
  - Needles
  - Syringes
  - Treated by conc. sulphuric acid/sharps pit
  - Big pearl pet jars especially designed vehicle
  - Contained in puncture proof container
  - Shredded and handed over to a waste contractor

Diagram 10: Sharps waste management flow chart in Sundaram Medical Foundation

- **Point of sharps use** (Injection unit) → Syringes and needles are manually separated
  - Needles
  - Syringes
  - Autoclaved/shredded and later send for smelting
  - Secure containers in specially designed vehicle
  - Contained in puncture proof container
  - Autoclaved/shredded and handed over to a waste contractor
Diagram 11: Sharps waste management flow chart at Tata Memoral Hospital

- Point of sharps use (Injection unit)
- Specially designed manual cutters
  - Needles
  - Syringes
  - Hydroclaved/shredded and disposed in landfill
  - Stored in dumpster
- Hydroclaved/shredded and handed over to a waste contractor

Diagram 12: Sharps waste management flow chart at Medi Care, Hyderabad

- Point of sharps use (Injection unit)
- Chemically disinfected and mutilated at source
  - Needles
  - Syringes
  - Autoclaved/encapsulated and sent to landfills
  - Contained in puncture proof container
  - Autoclaved/shredded and handed over to a waste contractor
Diagram 13: Sharps waste management flow chart at GJM Multiclave, Hyderabad

Point of sharps use (Injection unit) → Chemically disinfected and mutilated at source → Needles → Syringes → Autoclaved/encapsulated and sent to landfills → Contained in puncture proof container → Autoclaved/shredded and handed over to a waste contractor

Diagram 14: Sharps waste management flow chart in Sub Divisional District Hospital, Diamond Harbour, Kolkata

Point of sharps use (Injection unit) → Needle cutter → Chemical disinfection (Bleach solution) → Needles → Syringes → Municipal sites designated for medical waste → Contained in puncture proof container → Specially designed vehicle → Microwaved and handed over to a waste contractor
Diagram 15: Sharps waste management flow chart at Jawaharlal Nehru State Memorial Hospital

- **Point of sharps use (Injection unit)**
- **Needle cutter**
- **Chemical disinfection (Bleach solution)**
- **Needles**
- **Syringes**
- **Chemical disinfection (Bleach solution)**
- **Contained in puncture proof container**
- **Deep burial pit**
- **Specially designed vehicle**
- **Autoclaved and handed over to a waste contractor**
Annex 2
WHO Health Care Waste Policy, 2005

WORLD HEALTH ORGANIZATION

Safe health-care waste management
POLICY PAPER

1 Unsafe health-care waste management leads to death and disability

Health-care activities lead to the production of waste that may lead to adverse health effects. Most of this waste is not more dangerous than regular household waste. However, some types of health-care waste represent a higher risk to health. These include infectious waste (15% to 25% of total health-care waste) among which are sharps waste (1%), body part waste (1%), chemical or pharmaceutical waste (3%), and radioactive and cytotoxic waste or broken thermometers (less than 1%).

Sharps waste, although produced in small quantities, is highly infectious. Poorly managed, they expose health-care workers, waste handlers and the community to infections. Contaminated needles and syringes represent a particular threat and may be scavenged from waste areas and dump sites and be reused. WHO has estimated that, in 2000, injections with contaminated syringes caused:

- 21 million hepatitis B virus (HBV) infections (32% of all new infections);
- two million hepatitis C virus (HCV) infections (40% of all new infections);
- 260 000 HIV infections (5% of all new infections).

Epidemiological studies indicate that a person who experiences one needle-stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3% respectively to become infected with HBV, HCV and HIV. In 2002, the results of a WHO assessment conducted in 22 developing countries showed that the proportion of health-care facilities that do not use proper waste disposal methods ranges from 18% to 64%.
2 Health-care waste management may also represent a risk to health

Health-care waste management options may themselves lead to risks to health and no perfect readily achievable solution to manage health-care waste exists. Health-care waste, whether generated at smaller rural clinics or larger facilities, can be managed where adequate well-operated infrastructures exist. However, the volumes of waste generated within large facilities and targeted public efforts (e.g., immunization campaigns) are more challenging, particularly in developing countries where resources may be limited. In these difficult situations for which waste disposal options are limited, small-scale incinerators have been used and are still used as an interim solution in less developed and transitional countries. However, small-scale incinerators often operate at temperatures below 800 degrees Celsius. This may lead to the production of dioxins, furans or other toxic pollutants as emissions and/or in bottom fly ash. Transport to centralised disposal facilities may also produce hazards to health-care handlers, if not safely managed.

3 Balancing risks to make sound policy decisions in health-care waste management

In addition to risks to health from infectious agents, long-term low-level exposure of humans to dioxins and furans may lead to impairment of the immune system, and impaired development of the nervous system, the endocrine system and the reproductive functions. Short-term high level exposure may result in skin lesions and altered liver function.

The International Agency for Research on Cancer (IARC) classifies dioxins as a “known human carcinogen”. However, most of the evidence documenting the toxicity of dioxins and furans is based upon studies of populations that have been exposed to high concentrations of dioxins either occupationally or through industrial accidents. There is little evidence to determine whether chronic low-level exposure to dioxins and furans causes cancer in humans. Overall, it is not possible to estimate the global burden of diseases from exposure to dioxins and furans because of large areas of uncertainty.

In the last 10 years, the enforcement of stricter emission standards for dioxins and furans by many countries significantly reduced the release of these substances into the environment[1].

In several Western European countries where tight emissions restrictions were adopted in the late 1980s, dioxin and furan concentrations in many types of food (including breast milk) have decreased sharply.

WHO has established tolerable intake limits for dioxins and furans, but not for emissions. The latter must be set within the national context.
4 Guiding policy principles

In view of the challenge represented by health-care waste and its management, WHO activities are oriented by the following guiding principles:

- Preventing the health risks associated with exposure to health-care waste for both health workers and the public by promoting environmentally sound management policies for health-care waste;
- Supporting global efforts to reduce the amount of noxious emissions released into the atmosphere to reduce disease and defer the onset of global change;
- Supporting the Stockholm Convention on Persistent Organic Pollutants (POPs);
- Supporting the Basel Convention on hazardous and other waste; and
- Reducing the exposure to toxic pollutants associated with the combustion process through the promotion of appropriate practices for high temperature incineration.

5 Strategy

To better understand the problem of health-care waste management, WHO guidance recommends that countries conduct assessments prior to any decision as to which health-care management methods be chosen. Tools are available to assist with the assessment and decision-making process so that appropriate policies lead to the choice of adapted technologies. WHO proposes to work in collaboration with countries through the following strategies:

Short-term:

- Production of all syringe components made of the same plastic to facilitate recycling;
- Selection of PVC-free medical devices;
- Identification and development of recycling options wherever possible (e.g.: for plastic, glass,
- Research and promotion on new technology or alternative to small-scale incineration;

Until countries in transition and developing countries have access to health-care waste management options that are safer to the environment and health, incineration may be an acceptable response when used appropriately. Key elements of appropriate operation of incinerators include effective waste reduction and waste segregation, placing incinerators away from populated areas, satisfactory engineered design, construction following appropriate dimensional plans, proper operation, periodic maintenance, and staff training and management.
Medium-term:

- Further efforts to reduce the number of unnecessary injections to reduce the amount of hazardous health-care waste that needs to be treated;
- Research into the health effect of chronic exposure to low levels of dioxin and furan; and
- Risk assessment to compare the health risks associated with: (1) incineration; and (2) exposure to health-care waste.

Long-term:

- Effective, scaled-up promotion of non-incineration technologies for the final disposal of health-care waste to prevent the disease burden from: (a) unsafe health-care waste management; and (b) exposure to dioxins and furans;
- Support to countries in developing a national guidance manual for sound management of health-care waste;
- Support to countries in the development and implementation of a national plan, policies and legislation on health-care waste;
- Promotion of the principles of environmentally sound management of health-care waste as set out in the Basel Convention; and
- Support to allocate human and financial resources to safely manage health-care waste in countries
Annex 3
Questionnaires Used for this Study

Questionnaire for administrators:

(1) Collect general information about the hospital:
   - Name of the hospital
   - Type of hospital
   - Year of commencement
   - Number of beds
   - Occupancy rate
   - In/Out Patients
   - Other facilities provided
   - Catchments area

(2) What is the present waste management system in the hospital?
   - Details of the system
   - How did the present system develop?
   - Any training imparted
   - Regular monitoring and record keeping

(3) What is the role of different personnel’s involved in the system?

(4) What is the present sharps management system of the hospital?
   - At the point of generation, collection and final disposal site.
   - Money and Manpower required for the same.
   - Any stand by mechanism for managing sharps at each point
   - Quantity of sharps generated per day
   - Frequency of collection of sharps - everyday / _______ in a week

(5) What are the reasons for choosing the present system?

(6) Do you use a sharps pit for final disposal?
7. If the unit has a sharps pit, what are the dimensions of the pit and where were the specifications derived from?

8. If Yes, how do you transfer the waste into the sharps pit?

9. Is the method safe?

10. Is the pit with a funnel/pipe?

11. Is any disinfectant added to the pit?

12. For how long do you think that this system will last?

13. If no, what are the other methods used? Where do you store the waste before sending the waste for encapsulation or any other final disposal?

14. What was the investment in terms of capital cost and labour?
   - The total investment for sharps management (needle destroyers/ sharps pit)
     - Recurring cost

15. Is this an economically and environmentally viable option?

16. Is the final disposal site located in a secure area?

17. Have there been any incidences of scavenging in the past?

18. Do you think that the present system of sharps management is easy and safe or should a new system be developed?

19. What do you plan to do if the pit gets full?

20. What are the occupational safety measures introduced by the hospital?
   - Protective Clothing
   - Immunization
   - Accident reporting
   - Post prophylactic measures

21. Are you satisfied with the present system or will you suggest a different system?

22. With AD syringes being used in immunization programs the volume of medical waste will increase exponentially. How do you suggest handling such large volumes of waste?
23. How would you store the waste before sending for final disposal?

24. Any other comments

**Questionnaire for nurses:**

1. What is the present waste management system in the hospital?
   - Details of the system
   - Any training imparted
   - Regular monitoring and record keeping

2. What is the role of different personnel’s involved in the system?

3. What is the present sharps management system of the hospital?

4. Different categories of sharps generated.

5. How are sharps managed at the point of generation, collection and final disposal site.

6. Method for sharps collection from the patients bed side to the nursing station
   - Are the sharps stored in Puncture proof containers/ bags
   - Is the container closed/ open
   - Any disinfectant used in the container
   - How often is the disinfectant replaced
   - Are the sharps destroyed individual or in bulk
   - If in bulk, why?

7. How are the sharps destroyed?
   - Do you use needle destroyers and cutters
   - Electric/ mechanical
   - How often does the machine gets out of order
   - Any stand by mechanism for managing sharps at the point of generation
   - If manual, what are the methods used?

8. Are you comfortable with the present system?
   - Is it easy to operate the machine
   - Any fine emissions while operating the machine
9. Do you get needle stick injuries?
   - How often do you get one?
   - What are the reasons for it?
   - What is the most common reason for a sharps injury?
   - What are the precautions taken in case of an injury?

10. Occupational safety while handling sharps?
   - Protective gears are provided
   - If yes, are they being used regularly
   - If no, what are the reasons for not using them

11. How is the waste carried from the point of generation to the final disposal site
   - How often are the bins emptied
   - Are the sharps bin emptied regularly or how often?
   - Are the sharps collected manually in open bins/secure puncture proof containers or polythene bags?
   - What are the precautions taken by them?

12. Do you think that the present system of sharps management is easy and safe or should a new system be developed?

**Questionnaire for housekeeping staff:**

1. What is your duty in the hospital?

2. What kinds of waste do you collect?

3. Are you aware of the dangers associated with waste specially sharps?

4. Are you aware of the present system of sharps management in the hospital?

5. Does anyone regularly monitor the system?

6. Was any training on waste management imparted?

7. How is the waste treated at the point of generation?

8. What is the collection method from the point of generation?

9. How is the waste carried from the point of generation to the final disposal site
• How often are the bins emptied
• Are the sharps bin emptied regularly or how often
• Are the sharps collected manually in open bins/ secure puncture proof containers or polythene bags
• What are the precautions taken by them

10. Do you get needle stick injuries while handling waste?

11. How often do you get one and what are the common causes for this?

12. What do you do if you get an injury?

13. Do you report about the injury to your seniors?

14. What precautions do you take while handling waste specially sharps?

15. Are you vaccinated against Tetanus and Hepatitis B

16. Do you wear protective gears while handling waste?

17. Are you comfortable with the present system?
   • Is it easy to operate the machine
   • Any fine emissions while operating the machine

18. How is the waste carried from the point of generation to the final disposal site?

19. Do you use a sharps pit for final disposal?

20. If Yes, How do you transfer the waste into the sharps pit?

21. Is the method safe?

22. Is the pit with a funnel/ pipe?

23. Is any disinfectant added to the pit

24. If no, what are the other methods used? Where do you store the waste before sending the waste for encapsulation or any other final disposal?

25. What is the present system of sharps disposal in the hospital

26. Is the final disposal site located in a secure area?
27. Have there been any incidences of scavenging in the past?

28. Do you think that the present system of sharps management is easy and safe or should a new system be developed?

29. Any other comments

**Questionnaire for technology operators:**

1. Which technology is used?

2. When was it installed?

3. What is its capacity?

4. Hours of operation of the machine?

5. What kinds of waste are treated?

6. Are sharps also treated by this technology?

7. What is the final residue?

8. How is the residue disposed?

9. What is the environmental pollution control devices installed?

10. Does the technology have the approval of CPCB?

11. What are the occupational hazards associated with the technology?

12. What are the precautions taken by the operators?
   - Years of operation
   - Any injury caused while operating the machine
   - Use of protective gears
   - Immunization

13. What is the operating cost of the machine
   - Manpower
   - Electricity
   - Diesel
• Repair and Maintenance
• Bags / bins used
• Space provided

14. What will be the cost of sending the waste to a centralized facility?

15. Do you think that the present system is satisfactory or will you recommend a new system?

16. Any other comments

**Questionnaire for medical officers:**

1. Collect general information about the HCI:
   • Name of the HCI
   • Type of HCI
   • Year of commencement
   • Number of beds
   • Occupancy rate
   • In/ Out Patients
   • Other facilities provided
   • Catchments area

2. What is the present waste management system in the HCI?
   • Details of the system
   • How did the present system develop?
   • Any training imparted
   • Regular monitoring and record keeping

3. What is the role of different personnel’s involved in the system?

4. What is the present sharps management system of the hospital?
   • At the point of generation, collection and final disposal site.
   • Money and Manpower required for the same.
   • Any stand by mechanism for managing sharps at each point
   • Quantity of sharps generated per day
   • Frequency of collection of sharps - everyday / _______ in a week

5. What are the reasons for choosing the present system?
6. What was the investment in terms of capital cost and labour?
   • The total investment for sharps management (needle destroyers/ sharps pit)
   • Recurring cost

7. Is this an economically and environmentally viable option?

8. Is the final disposal site located in a secure area?

9. Have there been any incidences of scavenging in the past?

10. Do you think that the present system of sharps management is easy and safe or should a new system be developed?

11. What are the occupational safety measures introduced by the hospital
    • Protective Clothing
    • Immunization
    • Accident reporting
    • Post prophylactic measures

12. Are you satisfied with the present system or will you suggest a different system?
    • With AD syringes being used in immunization programs the volume of medical waste will increase exponentially. How do you suggest handling such large volumes of waste?

13. How would you store the waste before sending for final disposal?
## Annex 4

### List of Alternative Technology Manufacturers and Suppliers

(Note: The designations employed and the presentation of material in this publication do not imply the expression of any opinion or endorsement whatsoever on the part of the Secretariat of the World Health Organization)

#### Autoclave suppliers

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Address</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omron Medical Pvt.Ltd</td>
<td>J-133, R.B Enclave, Paschim Vihar, New Delhi-110063</td>
<td>Phone. No: 011-25681536/25682541</td>
</tr>
<tr>
<td>Samsung Textrade</td>
<td>33/15, Rajpur Road, Civil Lines, New Delhi-110054</td>
<td>Phone No: 011-23944927, Fax No: 011-23926448 Email: <a href="mailto:Pdhawan_77@hotmail.com">Pdhawan_77@hotmail.com</a></td>
</tr>
<tr>
<td>Rockwell Industrial Plants Limited</td>
<td>I-162A/12, Laxmi Nagar, New Delhi-110092</td>
<td>Phone No: 22016961/2/3, Email: <a href="mailto:ripl@riplindia.com">ripl@riplindia.com</a></td>
</tr>
<tr>
<td>Medi Aid Technology Services</td>
<td>Nazar Singh place S-19 II Floor 252 Sant Nagar East of Kailash New Delhi-65</td>
<td>Phone No: 011-26405329, Email: <a href="mailto:medi_delhi@satyamonline.com">medi_delhi@satyamonline.com</a></td>
</tr>
<tr>
<td>Aditya Diagnostics Pvt. Ltd. (San-i-Pak)</td>
<td>C 5/29 S D A O pp IIIT Gate Outer Ring Road, New Delhi 110016</td>
<td>Phone No: 011-26527290, 011-26513958 Email: <a href="mailto:mri@ndf.vsnl.net.in">mri@ndf.vsnl.net.in</a></td>
</tr>
<tr>
<td>Machin Fabrik</td>
<td>B 12 Arjun Centra B S D Marg Govandi Mumbai 400088</td>
<td>Phone No: 022-25555596, Fax No: 022-25560569 Email: <a href="mailto:machinfabrik@vsnl.com">machinfabrik@vsnl.com</a></td>
</tr>
<tr>
<td>A W S Clinical Waste</td>
<td>S N G Mercantile Pvt Ltd 4 Ganesh Chandra Avenue 5th Floor Kolkata 700013</td>
<td>Phone No: 033-2373878, Fax No:033-2466856 Email: <a href="mailto:forsuri@rediffmail.com">forsuri@rediffmail.com</a></td>
</tr>
</tbody>
</table>

#### Advanced autoclave suppliers

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Address</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>E A M Solution India LTD</td>
<td>FF 30 Avishkar Complex, Old Padra Road Vadodara 390015</td>
<td>Phone No:265-2358869, Fax No: 265-2301474 Email <a href="mailto:eamsol@sify.com">eamsol@sify.com</a></td>
</tr>
<tr>
<td>Multi Fab (Gujarat) Pvt LTD</td>
<td>403 g I D C Estate, Makarpura Road Vadodara 390010 Gujarat</td>
<td>Phone No: 265-2643321 Email - <a href="mailto:multifab@wilnetonline.net">multifab@wilnetonline.net</a></td>
</tr>
</tbody>
</table>
Shredded suppliers

Omron Medical Pvt.Ltd
J-133, R.B Enclave,
Paschim Vihar, New Delhi-110063
Phone. No: 011- 25681536/ 25682541
Fax No: 011-25580964

Health Care Projects (H- PAMCO )
Jhurmut 165, D.D.A., Khirki
Malviya Nagar, New Delhi- 110017
Phone: 011-26210826, 26291828
Email: H -pamco@123india.com

Needle destroyer/cutter manufactures

Mansa-implex
2 DLF Industrial Area,
Najafgarh Road,
New Delhi-110015
Phone No: 011-25440598

Robonik
31-D, Laxmi Industrial Estate,
Link Road, Anderi(W),
Mumbai- 400053

Penpol
Peninsula Polymers Ltd,
Cabin No.5, Basement-137 Sant Nagar,
East of Kailash, New Delhi- 110065
Phone No:011-26236436

Medi Aid Technology Services
Nazar Singh place S-19 II Floor
252 Sant Nagar
East of Kailash, New Delhi- 65
Phone No:011-26405329
Fax No: 011-26449503
Email: medi_delhi@satyamonline.com

Health Care Projects and Marketing Consultancy Organisation (H- PAMCO )
Jhurmut 165, D.D.A., Khirki
Malviya Nagar, New Delhi- 110017
Phone: 011-26210826, 26291828
Email: H -pamco@123india.com

Sumukha Power Systems (P) Ltd
No73/35, 5th Cross, Doddanna Ind. Estate,
Near Peenya 2nd Stage,
Bangalore-560091
Phone No: 080-28360160
Fax No: 080-28360690

MEDISYS
Plot P-1, Phase II, Dr. V.S.I Estate,
Thiruvanmiyur, Chennai-41
Phone No:044-24926053
Fax No: 044-24925763
Email- safemax@vsnl.com

M/s Biptronics
H-26A Saket,
New Delhi- 110017
Phone No: 011- 26962032, 26566608
Mobile- 9810009450
soumya@biptronics.com

Emmanuel Technologies
GODFREY A A 1035 3rd cross K N Extension
Yeshwanthpur Bangalore 560022
Phone No:080- 23474893

Core Health Care,
Core Towers Parimal Crossing,
Ellis Bridge, Ahmedabad
## Microwave suppliers

**Instromedix (India) Pvt. Ltd.**  
Pragati Chambers  
Ranjit Nagar Commercial Complex  
New Delhi- 110008  
Phone No: 011-25704965-67  
Email: instro@del2.vsnl.net.in

**METEKA**  
Pulse Pharma Pvt Ltd.  
208, Ashirwad Commercial Complex  
D-1, Green Park, New Delhi- 110016  
Phone No 011- 26863503, 26868878, 26863236  
Fax No: 011- 26868041, 26968517  
E mail: promed@vsnl.com

**Technoservice Ecologia**  
C/o Dr. Massimo Galli  
B-2/32, Safdarjung Enclave  
New Delhi- 110029  
Phone No /Fax No: 011- 26191997

## Shredder suppliers

**Omron Medical Pvt.Ltd**  
J-133, R.B Enclave,  
Paschim Vihar, New Delhi-110063  
Phone. No: 011- 25681536/25682541  
Fax No: 011-25580964

**Health Care Projects (H- PAMCO )**  
Jhurmut 165, D.D.A., Khirki Malviya Nagar, New Delhi- 110017  
Phone: 011-26210826, 26291828  
Email: H-pamco@123india.com
Notification, New Delhi, the 2nd June, 2000

S.O. 630 (E). – Whereas a notification in exercise of the powers conferred by Sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) was published in the Gazette vide S.O. 746 (E) dated 16 October, 1997 inviting objections from the public within 60 days from the date of the publication of the said notification on the Bio-Medical Waste (Management and Handling) Rules, 1998 and whereas all objections received were duly considered.

Now, therefore, in exercise of the powers conferred by section 6, 8 and 25 of the Environment (Protection) Act, 1986 the Central Government hereby notifies the rules for the management and handling of bio-medical waste.

1. Short title and commencement:

   (1) These rules may be called the Bio-Medical Waste (Management and Handling) (Second Amendment) Rules, 2000.

   (2) They shall come into force on the date of their publication in the official Gazette.

2. Application:

   These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio-medical waste in any form.

3. Definitions:

   In these rules unless the context otherwise requires

   (1) “Act” means the Environment (Protection) Act, 1986 (29 of 1986);

   (2) “Animal House” means a place where animals are reared/kept for experiments or testing purposes;
3. “Authorisation” means permission granted by the prescribed authority for the generation, collection, reception, storage, transportation, treatment, disposal and/or any other form of handling of bio-medical waste in accordance with these rules and any guidelines issued by the Central Government.

4. “Authorised person” means an occupier or operator authorized by the prescribed authority to generate, collect, receive, store, transport, treat, dispose and/or handle bio-medical waste in accordance with these rules and any guidelines issued by the Central Government;

5. “Bio-medical waste” means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals, and including categories mentioned in Schedule I;

6. “Biologicals” means any preparation made from organisms or micro-organisms or product of metabolism and biochemical reactions intended for use in the diagnosis, immunisation or the treatment of human beings or animals or in research activities pertaining thereto;

7. “Bio-medical waste treatment facility” means any facility wherein treatment, disposal of bio-medical waste or processes incidental to such treatment or disposal is carried out and includes common treatment facilities;

7a. “Form” means Form appended to these rules;

8. “Occupier” in relation to any institution generating bio-medical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called, means a person who has control over that institution and/or its premises;

9. “Operator of a bio-medical waste facility” means a person who owns or controls or operates a facility for the collection, reception, storage, transport, treatment, disposal or any other form of handling of bio-medical waste;

10. “Schedule” means schedule appended to these rules;

4. Duty of occupier:

It shall be the duty of every occupier of an institution generating bio-medical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment.

5. Treatment and disposal

(1) Bio-medical waste shall be treated and disposed of in accordance with Schedule I, and in compliance with the standards prescribed in Schedule V.

(2) Every occupier, where required, shall set up in accordance with the time-schedule in Schedule VI, requisite bio-medical waste treatment facilities
like incinerator, autoclave, microwave system for the treatment of waste, or, ensure requisite treatment of waste at a common waste treatment facility or any other waste treatment facility.

6. Segregation, packaging, transportation and storage

(1) Bio-medical waste shall not be mixed with other wastes.

(2) Bio-medical waste shall be segregated into containers/bags at the point of generation in accordance with Schedule II prior to its storage, transportation, treatment and disposal. The containers shall be labeled according to Schedule III.

(3) If a container is transported from the premises where bio-medical waste is generated to any waste treatment facility outside the premises, the container shall, apart from the label prescribed in Schedule III, also carry information prescribed in Schedule IV.

(4) Notwithstanding anything contained in the Motor Vehicles Act, 1988, or rules there under, untreated biomedical waste shall be transported only in such vehicle as may be authorized for the purpose by the competent authority as specified by the government.

(5) No untreated bio-medical waste shall be kept stored beyond a period of 48 hours provided that if for any reason it becomes necessary to store the waste beyond such period, the authorized person must take permission of the prescribed authority and take measures to ensure that the waste does not adversely affect human health and the environment.

(6) The Municipal body of the area shall continue to pick up and transport segregated non bio-medical solid waste generated in hospitals and nursing homes, as well as duly treated bio-medical wastes for disposal at municipal dump site.

7. Prescribed authority

(1) The prescribed authority for enforcement of the provisions of these rules shall be the State Pollution Control Boards in respect of States and the Pollution Control Committees in respect of the Union territories and all pending cases with a prescribed authority appointed earlier shall stand transferred to the concerned State Pollution Control Board, or as the case may be, the Pollution Control Committees.

(2) The prescribed authority for the State or Union Territory shall be appointed within one month of the coming into force of these rules.

(3) The prescribed authority shall function under the supervision and control of the respective Government of the State or Union Territory.

(4) The prescribed authority shall on receipt of Form 1 make such enquiry as it deems fit and if it is satisfied that the applicant possesses the necessary capacity to handle bio-medical waste in accordance with these rules, grant or renew an authorization as the case may be.
(5) An authorization shall be granted for a period of three years, including an initial trial period of one year from the date of issue. Thereafter, an application shall be made by the occupier/operator for renewal. All such subsequent authorization shall be for a period of three years. A provisional authorization will be granted for the trial period, to enable the occupier/operator to demonstrate the capacity of the facility.

(6) The prescribed authority may after giving reasonable opportunity of being heard to the applicant and for reasons thereof to be recorded in writing, refuse to grant or renew authorization.

(7) Every application for authorization shall be disposed of by the prescribed authority within ninety days from the date of receipt of the application.

(8) The prescribed authority may cancel or suspend an authorization, if for reasons, to be recorded in writing, the occupier/operator has failed to comply with any provision of the Act or these rules:

Provided that no authorization shall be cancelled or suspended without giving a reasonable opportunity to the occupier/operator of being heard.

8. Authorization

(1) Every occupier of an institution generating, collecting, receiving, storing, transporting, treating, disposing and/or handling bio-medical waste in any other manner, except such occupier of clinics, dispensaries, pathological laboratories, blood banks providing treatment/service to less than 1000 (one thousand) patients per month, shall make an application in Form 1 to the prescribed authority for grant of authorization.

(2) Every operator of a bio-medical waste facility shall make an application in Form 1 to the prescribed authority for grant of authorization.

(3) Every application in Form 1 for grant of authorization shall be accompanied by a fee as may be prescribed by the Government of the State or Union Territory.

(4) The authorization to operate a facility shall be issued in Form IV, subject to conditions laid therein and such other condition, as the prescribed authority, may consider it necessary.

9. Advisory committee

The Government of every State/Union Territory shall constitute an advisory committee. The committee will include experts in the field of medical and health, animal husbandry and veterinary sciences, environmental management, municipal administration, and any other related department or organization including non-governmental organizations. As and when required, the committee shall advise the Government of the State/Union Territory and the prescribed authority on matters related to the implementation of these rules.
10. Annual report

Every occupier/operator shall submit an annual report to the prescribed authority in Form 11 by 31 January every year, to include information about the categories and quantities of bio-medical wastes handled during the preceding year. The prescribed authority shall send this information in a compiled form to the Central Pollution Control Board by 31 March every year.

11. Maintenance of records

(1) Every authorised person shall maintain records related to the generation, collection, reception, storage, transportation, treatment, disposal and/or any form of handling of bio-medical waste in accordance with these rules and any guidelines issued.

(2) All records shall be subject to inspection and verification by the prescribed authority at any time.

12. Accident reporting

When any accident occurs at any institution or facility or any other site where biomedical waste is handled or during transportation of such waste, the authorised person shall report the accident in Form III to the prescribed authority forthwith.

13. Appeal

Any person aggrieved by an order made by the prescribed authority under these rules may, within thirty days from the date on which the order is communicated to him, prefer an appeal in form V to such authority as the Government of State/Union Territory may think fit to constitute:

Provided that the authority may entertain the appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.


Without prejudice to rule 5 of these rules, the Municipal Corporations, Municipal Boards or Urban Local Bodies, as the case may be, shall be responsible for providing suitable common disposal/incineration sites for the biomedical wastes generated in the area under their jurisdiction and in areas outside the jurisdiction of any municipal body, it shall be the responsibility of the occupier generating bio-medical waste/operator of a bio-medical waste treatment facility to arrange for suitable sites individually or in association, so as to comply with the provisions of these rules.
Options given above are based on available technologies. Occupier/operator wishing to use other State-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down to enable the prescribed authority to consider grant of authorization.

Chemicals treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.

Mutilation/shredding must be such so as to prevent unauthorized reuse.

There will be no chemical pretreatment before incineration. Chlorinated plastics shall not be incinerated. Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas.

### Schedule I: Categories of bio-medical waste (see rule 5)

<table>
<thead>
<tr>
<th>Waste Category No.</th>
<th>Waste Category Type</th>
<th>Treatment and Disposal Option+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category No. 1</td>
<td>Human Anatomical Waste (human tissues, organs, body parts)</td>
<td>incineration@ /deep burial*</td>
</tr>
<tr>
<td>Category No. 2</td>
<td>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 houses)</td>
<td>incineration@ /deep burial*</td>
</tr>
<tr>
<td>Category No. 3</td>
<td>Microbiology &amp; Biotechnology Waste (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures)</td>
<td>local autoclaving/microwave/incineration@</td>
</tr>
<tr>
<td>Category No. 4</td>
<td>Waste sharps (needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)</td>
<td>disinfection (chemical treatment@ / autoclaving/microwave and mutilation/shredding)</td>
</tr>
<tr>
<td>Category No. 5</td>
<td>Discarded Medicines and Cytotoxic drugs (wastes comprising of outdated, contaminated and discarded medicines)</td>
<td>incineration@ /destruction and drugs disposal in secured landfills</td>
</tr>
<tr>
<td>Category No. 6</td>
<td>Soiled Waste (items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)</td>
<td>incineration/ autoclaving /microwaving</td>
</tr>
<tr>
<td>Category No. 7</td>
<td>Solid Waste (wastes generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets etc.)</td>
<td>disinfection by chemical treatment@ @ autoclaving/microwaving and mutilation/shredding##</td>
</tr>
<tr>
<td>Category No. 8</td>
<td>Liquid Waste (waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities)</td>
<td>disinfection by chemical treatment@ @ and discharge into drains.</td>
</tr>
<tr>
<td>Category No. 9</td>
<td>Incineration Ash (ash from incineration of any bio-medical waste)</td>
<td>disposal in municipal landfill</td>
</tr>
<tr>
<td>Category No. 10</td>
<td>Chemical Waste (chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.)</td>
<td>chemical treatment@ @ and discharge into drains for liquids and secured landfill for solids</td>
</tr>
</tbody>
</table>
### Schedule II: Colour coding and type of container for disposal of bio-medical wastes (see rule 6)

<table>
<thead>
<tr>
<th>Colour Coding</th>
<th>Type of Container - I Waste Category</th>
<th>Treatment options as per Schedule I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Plastic bag Cat. 1, Cat. 2, and Cat. 3, Cat. 6.</td>
<td>Incineration/deep burial</td>
</tr>
<tr>
<td>Red</td>
<td>Disinfected container/plastic bag Cat. 3, Cat. 6, Cat. 7.</td>
<td>Autoclaving/Microwaving/Chemical Treatment</td>
</tr>
<tr>
<td>Blue/White translucent</td>
<td>Plastic bag/puncture proof Cat. 4, Cat. 7. Container</td>
<td>Autoclaving/Microwaving/Chemical Treatment and destruction/shredding</td>
</tr>
<tr>
<td>Black</td>
<td>Plastic bag Cat. 5 and Cat. 9 and Cat. 10. (solid)</td>
<td>Disposal in secured landfill</td>
</tr>
</tbody>
</table>

**Notes:**
1. Colour coding of waste categories with multiple treatment options as defined in Schedule I, shall be selected depending on treatment option chosen, which shall be as specified in Schedule I.
2. Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
3. Categories 8 and 10 (liquid) do not require containers/bags.
4. Category 3 if disinfected locally need not be put in containers/bags.

### Schedule III: Label for bio-medical waste containers/bags (see rule 6)

- **Bio-hazard symbol**
- **Cytotoxic hazard symbol**

**Handle with care**

Note: Label shall be non-washable and prominently visible
Schedule IV: Label for transport of bio-medical waste containers/bags (see rule 6)

<table>
<thead>
<tr>
<th>Day ..........</th>
<th>Month ..........</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year ..........</td>
<td></td>
</tr>
<tr>
<td>Date of generation ...............</td>
<td></td>
</tr>
<tr>
<td>Waste category No ........</td>
<td></td>
</tr>
<tr>
<td>Waste class</td>
<td></td>
</tr>
<tr>
<td>Waste description</td>
<td></td>
</tr>
</tbody>
</table>

Sender’s Name & Address

Phone No ........
Telex No ....
Fax No ..............
Contact Person ........

Receiver’s Name & Address

Phone No ..............
Telex No ..............
Fax No ..............
Contact Person ........

In case of emergency please contact
Name & Address :

Phone No.

Note : Label shall be non-washable and prominently visible.

Schedule V: Standards for treatment and disposal of bio-medical wastes (see rule 5 and schedule 1)

Standards for incinerators:

All incinerators shall meet the following operating and emission standards

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The Combustion efficiency is computed as follows:

\[
\text{C.E.} = \frac{\%CO_2}{\%CO_2 + \%CO} \times 100
\]

3. The temperature of the primary chamber shall be 800 ± 50°C.
4. The secondary chamber gas residence time shall be at least 1 (one) second at 1050 ± 50°C, with minimum 3% oxygen in the stack gas.

B. Emission Standards

Parameters Concentration mg/Nm³ at (12% CO₂ correction)

1. Particulate matter 150
2. Nitrogen Oxides 450
(3) HCL 50
(4) Minimum stack height shall be 30 metres above ground
(5) Volatile organic compounds in ash shall not be more than 0.01%

**Note:**
- Suitably designed pollution control devices should be installed/retrofitted with the incinerator to achieve the above emission limits, if necessary.
- Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
- Chlorinated plastics shall not be incinerated.
- Toxic metals in incineration ash shall be limited within the regulatory quantities as defined under the Hazardous Waste (Management and Handling Rules,) 1989.
- Only low sulphur fuel like L.D.0dLS.H.S.1Diesel shall be used as fuel in the incinerator.

**Standards for waste autoclaving:**
The autoclave should be dedicated for the purposes of disinfecting and treating biomedical waste,

(1) When operating a gravity flow autoclave, medical waste shall be subjected to:
   - a temperature of not less than 121°C and pressure of 15 pounds per square inch (psi) for an autoclave residence time of not less than 60 minutes; or
   - a temperature of not less than 135°C and a pressure of 31 psi for an autoclave residence time of not less than 45 minutes; or
   - a temperature of not less than 149°C and a pressure of 52 psi for an autoclave residence time of not less than 30 minutes.

(2) When operating a vacuum autoclave, medical waste shall be subjected to a minimum of one pre-vacuum pulse to purge the autoclave of all air. The waste shall be subjected to the following:
   - a temperature of not less than 121°C and pressure of 15 psi per an autoclave residence time of not less than 45 minutes; or
   - a temperature of not less than 135°C and a pressure of 31 psi for an autoclave residence time of not less than 30 minutes;

(3) Medical waste shall not be considered properly treated unless the time, temperature and pressure indicators indicate that the required time, temperature and pressure were reached during the autoclave process. If for any reasons, time temperature or pressure indicator indicates that the required temperature, pressure or residence time was not reached, the entire load of medical waste must be autoclaved again until the proper temperature, pressure and residence time were achieved.
(4) Recording of operational parameters

Each autoclave shall have graphic or computer recording devices which will automatically and continuously monitor and record dates, time of day, load identification number and operating parameters throughout the entire length of the autoclave cycle.

(5) Validation test

Spore testing:

The autoclave should completely and consistently kill the approved biological indicator at the maximum design capacity of each autoclave unit. Biological indicator for autoclave shall be Bacillus stearothermophilus spores using vials or spore strips, with at least $1 \times 10^4$ spores per millilitre. Under no circumstances will an autoclave have minimum operating parameters less than a residence time of 30 minutes, regardless of temperature and pressure, a temperature less than 121°C or a pressure less than 15 psi.

(6) Routine Test

A chemical indicator strip/tape that changes colour when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that the inner content of the package has been adequately autoclaved.

**Standard for liquid waste:**

The effluent generated from the hospital should conform to the following limits

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Permissible limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>63-9.0</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>100 mg/l</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>10 mg/l</td>
</tr>
<tr>
<td>BOD</td>
<td>30 mg/l</td>
</tr>
<tr>
<td>COD</td>
<td>250 mg/l</td>
</tr>
<tr>
<td>Bio-assay test</td>
<td>90% survival of fish after 96 hours in 100% effluent.</td>
</tr>
</tbody>
</table>

These limits are applicable to those, hospitals which are either connected with sewers without terminal sewage treatment plant or not connected to public sewers. For discharge into public sewers with terminal facilities, the general standards as notified under the Environment (Protection) Act, 1986 shall be applicable.

**Standards of microwaving**

(1) Microwave treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.
(2) The microwave system shall comply with the efficacy test/routine tests and a performance guarantee may be provided by the supplier before operation of the limit.

(3) The microwave should completely and consistently kill the bacteria and other pathogenic organisms that are ensured by approved biological indicator at the maximum design capacity of each microwave unit. Biological indicators for microwave shall be Bacillus subtilis spores using vials or spore strips with at least $1 \times 10^4$ spores per milliliter.

Standards of deep burial

(1) A pit or trench should be dug about 2 metres deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.

(2) It must be ensured that animals do not have any access to burial sites. Covers of galvanised iron/wire meshes may be used.

(3) On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.

(4) Burial must be performed under close and dedicated supervision.

(5) The deep burial site should be relatively impermeable and no shallow well should be close to the site.

(6) The pits should be distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or ground water. The area should not be prone to flooding or erosion.

(7) The location of the deep burial site will be authorised by the prescribed authority.

(8) The institution shall maintain a record of all pits for deep burial.

Schedule VI: Schedule for waste treatment facilities like incinerator/autoclave/microwave system (see rule 5)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hospitals and nursing homes in towns with population of 30 lakhs and above</td>
</tr>
<tr>
<td>2.</td>
<td>Hospitals and nursing homes in towns with population of below 30 lakhs,</td>
</tr>
<tr>
<td>(a)</td>
<td>with 500 beds and above</td>
</tr>
<tr>
<td>(b)</td>
<td>with 200 beds and above but less than 500 beds</td>
</tr>
<tr>
<td>(c)</td>
<td>with 50 beds and above but less than 200 beds</td>
</tr>
<tr>
<td>(d)</td>
<td>with less than 50 beds</td>
</tr>
<tr>
<td>3.</td>
<td>All other institutions generating biomedical waste not included in A and B above</td>
</tr>
</tbody>
</table>
Form I: Application for authorization/renewal of authorization (see rule 8)

(To be submitted in duplicate)

To The Prescribed Authority
(Name of the State Govt/UT Administration)
Address.

(1) Particulars of Applicant
   • Name of the Applicant
     (In block letters & in full)
   • Name of the Institution:
     Address: Tele No., Fax No. Telex No.

(2) Activity for which authorization is sought:
   • Generation
   • Collection
   • Reception
   • Storage
   • Transportation
   • Treatment
   • Disposal
   • Any other form of handling

(3) Please state whether applying for fresh authorization or for renewal:
   (In case of renewal previous authorization-number and date)

(4) • Address of the institution handling bio-medical wastes:
   • Address of the place of the treatment facility:
   • Address of the place of disposal of the waste:

(5) • Mode of transportation (in any) of bio-medical waste:
   • Mode(s) of treatment:

(6) Brief description of method of treatment and disposal (attach details):

(7) • Category (see Schedule 1) of waste to be handled
   • Quantity of waste (category-wise) to be handled per month

Declaration
I do hereby declare that the statements made and information given above are true to the best of my knowledge and belief and that I have not concealed any information. I do also hereby undertake to provide any further information sought
by the prescribed authority in relation to these rules and to fulfill any conditions stipulated by the prescribed authority.

Date : Signature of the Applicant
Place : Designation of the Applicant

Form II: Annual report (see rule 10)
(To be submitted to the prescribed authority by 31 January every year).

(1) Particulars of the applicant:
- Name of the authorized person (occupier/operator):
- Name of the institution:
  Address , Tel. No , Fax No.

(2) Categories of waste generated and quantity on a monthly average basis:

(3) Brief details of the treatment facility:
  In case of off-site facility:
- Name of the operator
- Name and address of the facility:
  Tel. No., Telex No., Fax No.

(4) Category-wise quantity of waste treated:

(5) Mode of treatment with details:

(6) Any other information:

(7) Certified that the above report is for the period from
  Date......... Signature......... Place.......... Designation...............

Form III: Accident reporting (see rule 12)

1 Date and time of accident:
2 Sequence of events leading to accident
3 The waste involved in accident:
4 Assessment of the effects of the accidents on human health and the environment,
5 Emergency measures taken
6 Steps taken to alleviate the effects of accidents
7 Steps taken to prevent the recurrence of such an accident

Date......... Signature......... Place.......... Designation...............

A Report on Alternative Treatment and Non-Burn Disposal Practices
Form IV: Authorisation for operating a facility for collection, reception, treatment, storage transport and disposal of biomedical wastes [see Rule 8(4)]

(1) File number of authorisation and date of issue .................................................................

(2) ........................................................................ of ......................................................... is hereby granted an authorisation to operate a facility for collection, reception, storage, transport and disposal of biomedical waste on the premises situated at ............................................

(3) This authorisation shall be in force for a period of ............... Years from the date of issue.

(4) This authorisation is subject to the conditions stated below and to such other conditions as may be specified in the rules for the being in force under the Environment (Protection) Act, 1986.

Signature.....................Date............................

Designation ......................

Terms and conditions of authorisation*

(1) The authorisation shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made there under.

(2) The authorisation or its renewal shall be produced for inspection at the request of an officer authorised by the prescribed authority.

(3) The person authorised shall not rent, lend, sell, transfer or otherwise transport the biomedical wastes without obtaining prior permission of the prescribed authority.

(4) Any unauthorised change in personnel, equipment or working conditions as mentioned in the application by the person authorised shall constitute a breach of his authorisation.

(5) It is the duty of the authorised person to take prior permission of the prescribed authority to close down the facility.

* Additional terms and conditions may be stipulated by the prescribed authority.
Form V: Application for filing appeal against order passed by the prescribed authority at district level or regional office of the Pollution Control Board acting as prescribed authority or the State/Union Territory level authority (see Rule 13)

(1) Name and address of the person applying for appeal:

(2) Number, date of order and address of the authority which passed the order, against which appeal is being made (certified copy of order to be attached)

(3) Ground on which the appeal is being made

(4) List of enclosures other than the order referred in para 2 against which appeal is being filed.

Date............ Signature............. Name & Address.............
WHO we are...

Srishti is an environmental organization dedicated to the improvement of municipal, hazardous and medical waste management. Utilizing community outreach and education, policy analysis and initiatives, research, training and program development, we work at the state and central levels to create solutions for waste management, which are not technology but people driven. Srishti is also involved in a wider range of environmental issues in Delhi as part of a coalition of non-governmental organizations.

WHY we started work on medical waste...

Srishti started work on waste in early '90s and found that untreated infectious waste from the hospitals was reaching municipal dumps. This causes health problems to the ragpickers, municipal workers and the general public exposed to it. Poor hospital waste management takes its toll within the hospitals also. Entire hospital staff is prone to problems related to mismanagement of waste- specifically sharps waste. Improper disposal through incinerators creates additional health hazards; production of cancer-causing dioxins is one of them.

The turning point in all this was the 1996 directive of the Hon'ble Supreme Court of India, according to which all hospitals in Delhi above 50 beds were required to install incinerators. Srishti was instrumental in opposing this polluting and obsolete technology and successfully intervened for the modification of this order and the inclusion of non-polluting alternate technologies and their standards.

WHAT all have we been involved with in medical waste... .

- Intervention in the Supreme Court of India case of Dr. B.L. Wadhera Vs The Union of India for Standards for Medical Waste Incinerators
- Inclusion of alternative technologies and their standards
- Implementing waste management schemes in hospitals. (Srishti has set up such systems in 5 hospitals)
- Creating awareness through various seminars, community workshops and training programs.
• Part of the Central Pollution Control Board’s (CPCB) ‘Peer & Core’ group standards committee for Medical Waste technologies

• Srishti is a part of the committee formed under the Director General of Medical Services.

• We have worked with the Ministry of Environment & Forest for the creation of national standards for Bio-Medical Waste.

• Srishti is a member of the Advisory Committee to the Government of Delhi

• We have worked closely with World Health Organization, the World Bank and the United Nations Development Programme in their hospital waste management programmes.

• Our organization actively monitors and documents waste management practices in Delhi

Information dissemination and co-ordination

• Creating and disseminating reports, newsletter and fact sheets on medical waste management

• Organizing and conducting skill shares/ seminars/ workshops

• Working with different PCBs to spread awareness regarding the safe disposal of Bio-medical waste.

• Creating a database of information on medical waste practices.

• Helping building capacity of various organizations/ individuals
For more information please contact:

Alexander von Hildebrand
Environmental Health Advisor
World Health Organization
Regional Office for South-East Asia
Ring Road, New Delhi 110002, India
E-mail: sde@whosea.org
Website: www.whosea.org
Safe Management of Bio-medical Sharps Waste in India

A Report on Alternative Treatment and Non-Burn Disposal Practices