

# Understanding and simplifying bio-medical waste management

A training manual for trainers



Toxics Link, Revised May 2016

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## **About Toxics Link**

Toxics Link is an environmental NGO, dedicated to bringing toxics related information into the public domain, both relating to struggles and problems at the grassroots as well as global information to the local levels. We work with other groups around the country as well as internationally in an understanding that this will help bring the experience of the ground to the fore, and lead to a more meaningful articulation of issues. Toxics Link also engages in on-the ground work especially in areas of municipal, hazardous and medical waste management and food safety among others. We are also involved in a wider range of environmental issues in Delhi and outside as part of a coalition of non-governmental organisations.

**Understanding and simplifying bio-medical waste management**

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# Acknowledgements

**W**e would like to thank the various hospitals and state governments which provided us the wonderful opportunity to conduct training programmes around the country; this manual is a result of the experience and skills gathered and honed during these training programmes. Our special thanks to Dr. Glenn Mc Rae and Dr. Jorge Emmanuel of Healthcare Without Harm for reviewing specific text of this manual. And foremost to all the trainees who brought several practical issues to our notice and helped us improve the manual through their suggestions. Not to forget the entire Toxics Link family which was always supportive.

# An introduction to this manual

**T**he issue of medical waste management was first taken up in India around 1995. A lot has changed since then in the way medical waste is handled, stored, treated and disposed.

An important catalyst to this change have been the Bio-medical Waste (Management & Handling) Rules 1998, now Bio-Medical Waste Management Rules, 2016.

Framing the rules was one important aspect of waste management, but implementing the rules required that the medical fraternity understood the rules and adopted them into their professional environments. This was possible only through large-scale training of medical staff. Considering the geographical spread of India, and the size of its medical sector, this has been, and continues to be, a challenging task.

Toxics Link, has played its part in training healthcare professionals regarding medical waste management and the implementation of management systems in hospitals and other medical institutions. Srishti emphasises the importance of managerial interventions and staff dedication to bring about efficient waste management practices. It works towards dispelling the belief that technology is the only solution for medical waste management.

As our work with various hospitals has progressed, the training needs have also increased. As a result,

training has gradually become one of our focal areas. We have learnt from each training session; every hospital has its unique problems and challenges. As we attempted to resolve particular problems, and respond to the queries of the hospital staff, we enhanced our understanding of the practical problems and the unique needs of healthcare institutions. This helped us evolve our training methodology as well as its content.

Apart from training hospital staff, we have also conducted various Training of Trainers (ToT) programmes all around the country, in association with various hospitals and Pollution Control Boards/ Committees. These programmes create a brigade of trainers who act as ambassadors and take the message of waste management forward.

By the end of such sessions, trainees are exposed to a lot of information, but they do not have enough time to assimilate everything. Once they return to their workplaces, they have expressed the need for a comprehensive resource on training. This manual has been compiled to fulfill their requirement.

The main aim of the manual is to ensure that every healthcare worker and other stakeholders are aware of the hazards associated with improper bio-medical waste management.

The manual has been produced to provide a convenient, up-to-date training resource that will allow interested people and trainers to increase awareness on waste management and related issues

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at every level in their organisation.

The Training manual has eight sections and each section has slides on a particular topic. Most of the points in the slides are self explanatory, but some of them, which may need explanations, have descriptive notes.

This manual would keep evolving to address newer issues as experience in this field grows. Your suggestions and comments on the manual would therefore be highly appreciated.

# How to use this resource

**T**he manual has been divided into logical sections. Beginning with an overview that introduces the audience to history of Bio-medical waste and its management, the manual moves on to talk about the environmental and health impacts of mismanagement of Bio medical waste. This section introduces the audience to all the relevant conventions.

The next section deals with the implementation of bio-medical waste management system in a hospital. This section deals with segregation of waste, its transportation, management policies at hospitals and techniques that a hospital could follow to have a successful bio-medical waste management programme.

The section that now follows provides a step by step guide to the hospital in reducing its carbon footprint.

The Training of Staff section that follows focuses on specific kinds of bio-medical waste, such as sharps, glutaraldehyde and cytotoxic drugs. Each kind of waste is discussed, and the hazards associated with it are elaborated.

The next section, Aspects of Waste Management deals with managing each kind of bio-medical waste. This includes the processes to be followed and the precautions to be taken for different waste categories.

After this, the manual spells out the Rules and Policies that apply to medical institutions. This section is appropriate while training senior managerial staff at hospitals.

The last section entails the treatment technologies available for treatment of Bio medical waste and the role of a Common Bio medical waste treatment facility in the same.

Each of the above mentioned sections consists of slides that are provided as print-outs in this manual. The latest version of the presentations for this manual can be found at the following source:

<http://toxicslink.org/docs/bmw/bmw-training-m/index.htm>

Each of the above mentioned training modules are provided as PowerPoint presentations in the accompanying CD. The slides of the presentations also have hyperlinks to relevant pictures that visually depict a point. Depending on the resources available, trainers can either print out the slides and pictures or use a computer to make the presentations.

The manual also provides supporting material to key slides of each section. The trainer should study the section for which s/he wants to conduct a training session and familiarise herself/himself with the issues concerned. The level of elaboration of each slide and discussions around the topics will obviously depend on the kind of audience, its needs, knowledge-base and the purpose of the training. The trainer is expected to exercise discretion in making such decisions.

The trainer should be able to select a set of slides appropriate for a particular session. Some seminars, lecture series, discussion forums may need discussion on a particular issue. The specific sections can be in such sessions.

A few miscellaneous slides have also been provided. These slides can be used if a discussion starts to build around these topics in a training session.

# Suggested training mechanisms

## **Our experience with training**

We have dealt with a diverse audience while conducting training sessions on waste management: from medical students to practicing professionals, and ward boys to nursing staff. Each group required a different approach. It is important to consider the background of the audience you are about to train, and prepare the sessions in accordance with their knowledge levels, ability to grasp concepts, language and openness to new ideas.

## **Training nursing students**

Students respond well to a classroom situation. A question answer format is ideal for such an audience, as they enjoy the interactivity and are eager to display the knowledge that they have. Usually, a little guidance is required to channelise them into the right direction. Students are also very open to fresh ideas and are naturally inquisitive about developments in the 'real' world.

An effective technique is to approach the training as a problem-solving session.

## **Training ward boys**

Usually, this group responds well when the issues are connected to their daily routines and problems. It is a good idea to begin the session with listening to their problems, even if they are not necessarily related to waste management. A sympathetic ear

makes them shed their inhibitions, and be more open to the session.

The written word is best abandoned with this group. Innovative methods such as street plays are very effective, as this group responds well to drama and visual forms. One will find that this group will make valuable suggestions that can be adopted while setting up a waste management scheme.

## **Training with doctors**

Doctors require a more academic approach, which has well-researched data and working examples from other institutions.

Information about various international conventions, global movements and negotiations are required to convince them about the importance of waste management.

Often, they feel that the sessions are an imposition on them, therefore, their time should be respected and the sessions should be highly professional.

## **Training with staff nurses**

Training with staff nurses is the most critical as they form the backbone of the waste management system in a hospital. Nurses are generally quite interested and active. However, they might be in a hurry if they are required to attend the sessions after their shift. The timing of the training should be carefully chosen to avoid such issues. When it



cannot be avoided, the sessions must be made interesting through the use of various tools such as quizzes, placards, etc.

One can have nurses enact a particular procedure and dispose off waste generated during the course. Or one can have photographs of good and bad practices and ask people to point out problems in the photograph and suggest corrections. If trainees know that a quiz would follow the training session they are generally more alert during the trainings.

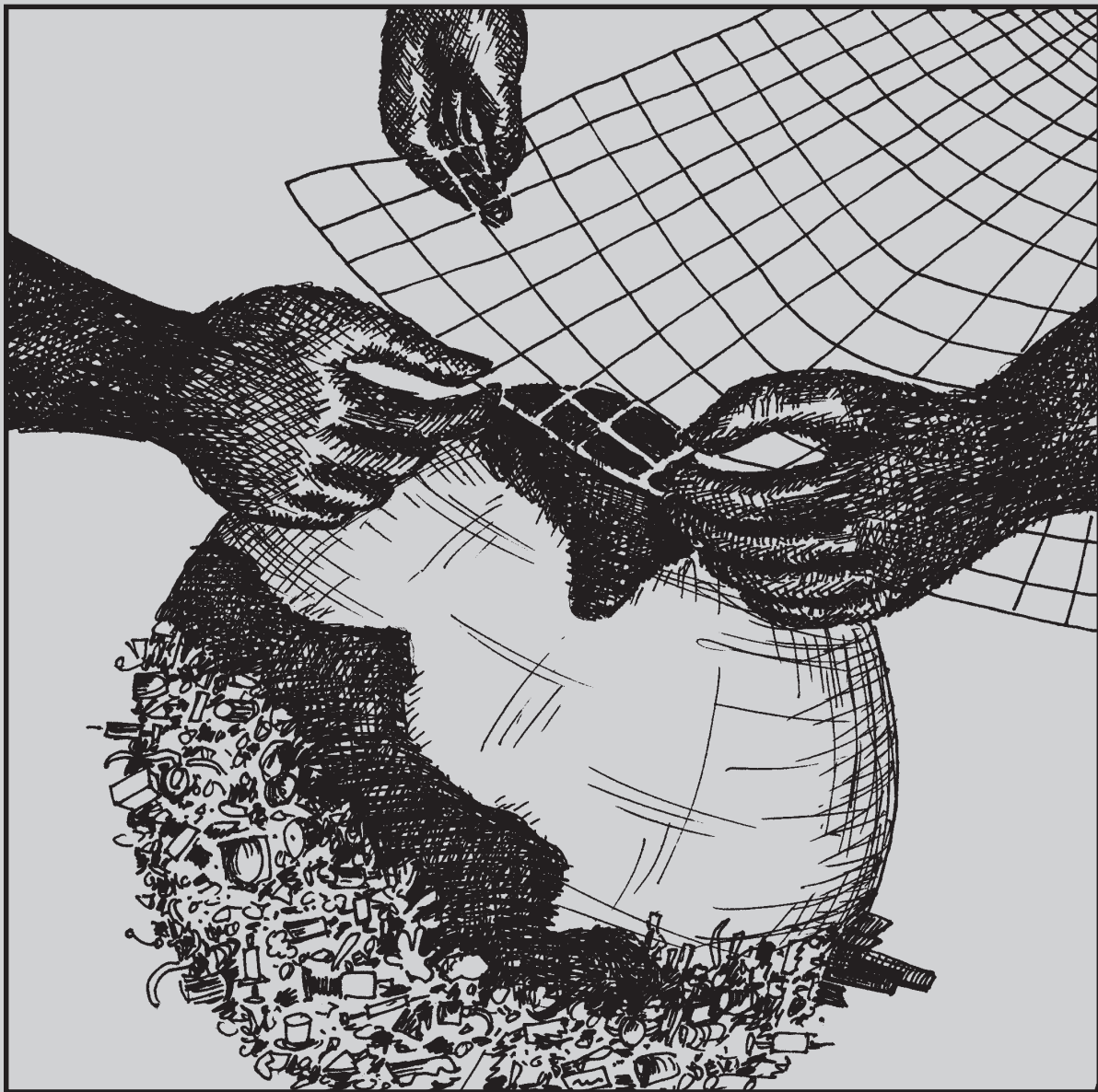
Any training can be made more effective with a good trainer, training tools and techniques. Thus the trainer should have good communication skills and should be able to mould the style of the presentation according to the target audience.

Visual aids help demonstrate good practices effectively. Representatives from another hospital which is following a sound waste management system can be called for sharing their experience.



# *Section A*

## **An overview of bio-medical waste management**



# A1 An overview of bio-medical waste management

**T**he public concern with medical waste dates back to the late 1980s when large quantities of syringes and needles were found on the beaches of east coast Florida, USA. About the same time, the HIV/AIDS epidemic was rearing its head and healthcare professionals were waking up to its enormity. The public outcry following the discovery of the needles, led to the formulation of the US Medical Waste Tracking Act (MWTa), which came into force on November 1, 1988.

A quick-fix solution that was employed was to buy and install small on-site incinerators. Retired incinerators were also resurrected, and in some cases more waste was added to the existing incinerators. Many of these incinerators were unregulated. A number of them had few, if any, pollution control devices. In the early 1990s the United States Environment Protection Agency (USEPA) estimated that there were some 6,000 hospital incinerators operating in USA.

Incineration, too, was opposed by communities living close to them as they were found to be seriously harming the health of people. Study after study exposed the hazards of incineration, and linked them to emissions of cancer-causing dioxin and furan. As a result, incinerators were phased out. By 2003 the number of incinerators in USA had come down to just about 115. [compilation by Dr. J. Emmanuel]

In India, concern for medical waste was an outcome of judicial and NGO interventions. Ministry of Environment and Forests came out with the first draft rules on bio-medical waste in 1995. It was the first time that medical waste was addressed as a category separate from municipal waste.

The problem with this draft was that it laid too much emphasis on incineration. All hospitals having 80 or more beds were asked to install on-site incinerators. Timely intervention by NGOs (Srishti being one of them), helped change this draft. The final rules had provisions for alternative technologies, standards for all listed technologies and centralised facilities for bio-medical waste treatment.

Concern about the environmental and health risks of medical waste incineration has increased in recent years as a number of studies have shown that incinerators are a major source of extremely toxic dioxin and other pollutants. In industrialised as well as less-industrialised countries, growing movements of health workers, labour and environmental advocates, and concerned citizens have called for the replacement of medical waste incinerators with cleaner, safer and less expensive alternatives.

In fact, NGOs have been lobbying for zero incineration facilities for medical waste treatment.

One problem with bio-medical waste has been that it has a complex composition, and one type of waste

can easily contaminate another, making it difficult to manage the waste. Around 80-90 per cent of waste generated in a hospital is general waste, and the remaining 10-20 per cent can be infectious and/or hazardous (for example, cytotoxic, chemical and radioactive waste). This breakup of waste also depends on the type of hospital and the facilities it has.

The different types of bio-medical waste generated at a single medical establishment requires different kinds of treatment technologies. It is highly impractical to expect each hospital to invest in these different technologies. This has led to the concept of centralised waste treatment facilities. As per the BMW Rules 2016, the hospitals need to treat their microbiological waste before giving it to CTFs.

The idea was mooted years ago, and as these facilities were being established, the second amendment to the Bio-medical Waste (Management and Handling) Rules came out with some new clauses for establishment of such facilities. As a number of these units started operating and countrywide experience started pouring in (regarding the problems being faced by the authorities, operators, subscribers, NGO observations, etc.), it was realised that some standards/guidelines were required for such facilities. Thus, in addition to the national guidelines for implementation of the rules, two new guidelines – Guidelines for Centralised Bio-medical Waste Treatment Facilities and Guidelines for Construction and Operation of Incinerators – were drafted by the Central Pollution Control Board.

At the same time, NGOs were demanding the elimination of incineration as a treatment option for bio-medical waste. Toxics Link compiled a national survey on incineration conducted by four members of HuMAN (Health and Us – Medical Waste Action Network): Chennai based CAG (Citizen consumer and civic Action Group); MMAG (Mumbai Medical Waste Action Group); Thanal, Trivandrum and Toxics Link,

New Delhi.

This survey was presented to the Ministry of Environment and Forests and the Central Pollution Control Board (CPCB) asking for a ban on incinerators. The CPCB wrote to all its state boards to discourage any new on-site incinerators, and later, during the course of finalisation of the draft on guidelines for centralised facilities, incineration was limited from five to three categories of bio-medical waste.

The new guidelines on incineration are very comprehensive and it would be economically unviable now to install any new on-site incinerators. The guidelines make it clear that on-site incinerators would not be allowed, other than in exceptional conditions where special approval would have to be sought from CPCB. Thus, in India no on site incinerators are now being permitted to be used at any healthcare facility. They are only installed in the Common Bio-Medical Waste Treatment Facility where they have to abide by certain standards. Bio-Medical Waste Management Rules, 2016 have made the standards for the operation of incinerators more stringent.

## **Slide 2: Various networks**

Worldwide, various organisations and networks are working to transform the healthcare industry so that it is not a source of harm to public health.

Safe Injection Global Network (SIGN) is a coalition of several public and private partners, including WHO, UNICEF, UNAIDS, NGOs, governments, and health workers. It was formed in Geneva in October 1999 to focus on injection safety, of which safe disposal is an important component.

Another network called Global Alliance for Incineration Alternatives, or Global Anti-Incineration Alliance (GAIA) is an international network of NGOs working against incineration

- 1. Safe management of waste from healthcare activities, A. Pruss et al, WHO, 1999.

- 2. Safe management of waste from healthcare activities, A. Pruss et al, WHO, 1999.

and is trying to promote safer alternatives to treat bio-medical waste.

Healthcare Without Harm (HCWH) is an international coalition of NGOs, hospitals, medical professionals, community groups and labour unions working on ecologically sustainable healthcare systems. Medical waste is one of their focus areas.

In India, too, environmental organisations and individuals have come together to form Health and Us - Medical Waste Action Network (HuMAN). This is a network of NGOs, academicians, practitioners, etc, lobbying for safe medical waste practices in the country. Its aim is to take the message of safe management of healthcare waste to the grassroots.

### Slide 3: What is this concern for?

*Infectious waste* is suspected to contain pathogens (bacteria, viruses, parasites or fungi) in sufficient concentrations to cause disease in susceptible hosts.

*Sharps* are items that could cause cuts or puncture wounds. They include hypodermic needles, scalpels and other blades, knives, infusion sets, saws, broken glass, and nails. They are considered highly hazardous whether they are infected or not.

*Cytotoxic* drugs have the ability to stop the growth of certain living cells and are used as chemotherapeutic agents. They are carcinogens and can also be mutagenic. Any material used to handle these products and contaminated in due course would also need to be disposed off in the same manner.

*Pharmaceutical waste* includes expired, unused, spilt and contaminated pharmaceutical products, drugs, vaccines and sera that are no longer useful.

*Radioactive waste* includes solid, liquid, and gaseous materials contaminated with radionuclides. Radioactive healthcare waste usually contains

radionuclides with short half-lives which lose their activity relatively quickly. Radioactive waste is generally produced in in-vitro analysis of body tissue and fluid, in-vivo organ imaging and tumour localisation, and various investigative and therapeutic practices.

The type of disease caused by radioactive waste is determined by the type and extent of exposure. It can range from headache, dizziness and vomiting, to much more serious problems. Radioactive waste is also genotoxic and handling of active sources may have severe consequences such as the destruction of tissue.<sup>1</sup>

*Chemicals* are generally used in diagnostic and experimental work, and in cleaning, housekeeping and disinfecting procedures. Many chemicals and pharmaceuticals used in hospitals are hazardous. They are termed hazardous if they have any one of the following properties: toxic, corrosive, flammable, reactive, genotoxic. Examples of such waste are formaldehyde, glutaraldehyde and photographic chemicals.

They may cause injuries, including burns. Disinfectants are particularly important members of this group as they are used in large quantities and are generally corrosive.<sup>2</sup>

### Slide 4: Know your waste

According to various estimates and surveys around 80-90 per cent of hospital waste is general waste and 10-20 per cent is infectious/hazardous. Of this, 15-20 per cent is pathological and infectious waste, one per cent is sharps waste, three per cent chemical/pharmaceutical and less than one per cent is special waste such as radioactive, cytotoxic drugs, etc. These percentages may be higher or lower depending on the type of hospital (for example, teaching, research and large general hospitals will have higher quantities of these wastes, while rural and small speciality hospitals may have much lower quantities).<sup>2</sup>

## Slide 5: Impacts of hospital waste

All individuals exposed to hazardous healthcare waste are potentially at risk. This includes persons within healthcare establishments and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management. The main groups at risk include doctors, nurses, patients, visitors to the hospital, workers in support services allied to hospitals like the laundry, workers in waste disposal facilities, etc.

The hazards associated with scattered, small sources of healthcare waste should not be overlooked; this can include waste generated by home-based healthcare.

## Slide 7: Concerns in infectious waste

Infectious waste may contain pathogens in sufficient concentration to cause disease. Infectious waste would include cultures and stocks of infectious agents from laboratory, pathological waste (tissues, organs, body parts, human foetus, animal carcass from research facilities, blood and body fluids) and sharps waste.

Pathogens in waste can invade the body through various routes, including a puncture, abrasion or a cut in the skin, through the mucous membrane or by inhalation/ingestion. Body fluids can act as transmission vehicles for various pathogens as listed in slide 17.

Infectious waste from hospitals is problematic because laboratories harbour not just resistant strains, but also concentrated cultures of micro-organisms. Existence of bacteria resistant to antibiotics and chemical disinfectants contributes to the hazards. It has been demonstrated that plasmids from laboratory strains contained in healthcare waste were transferred to indigenous bacteria via the waste disposal system.<sup>2</sup>

## Slide 10: What are sharps?

Anything that can cause a cut or a puncture wound is classified as 'sharps'. These include needles, hypodermic needles, scalpel and other blades, knives, infusion sets, saws, broken glass, and nails. Whether or not they are infected, sharps are usually considered highly hazardous healthcare waste because they have the potential to cross the passive and primary immunology barrier of the body – the skin – and thus establish contact with blood. Because of this double risk of injury and disease transmission sharps are considered very hazardous.

The principal concerns are infections that may be transmitted by subcutaneous introduction of the causative agent, for example, viral blood infections. Hypodermic needles constitute an important part of the sharps waste category and are particularly hazardous because they are often contaminated with blood.<sup>3</sup>

## Slide 11: Sero-conversion following exposure

Sero-conversion means the percentage of healthcare workers developing the infection after being exposed to body fluids from a proven infective source. These rates have been documented by carrying out a follow-up of healthcare workers with occupational exposure to blood from a patient positive for a particular blood-borne pathogen. For instance, in the case of exposure to a HIV positive patient, the healthcare worker would be tested for HIV antibodies at the time of exposure (baseline testing) and at periodic intervals for 12 months. (Also refer to slide 10 of the section titled *Training hospital staff*).

## Slide 14: Reuse

Unsafe injection practices transmit blood-borne pathogens such as Hepatitis B, Hepatitis C and HIV. Globally, nearly two per cent of all new HIV infections are caused by unsafe injection practices

→ 3. Safe management of waste from healthcare activities, A. Pruss et al, WHO, 1999.

→ 4. [www.injectionsafety.org](http://www.injectionsafety.org)

with a total of 96,000 people infected annually.<sup>4</sup>

Reuse of syringes and needles, without their sterilisation, exposes millions of people to the risk of these infections.

The problem of unsafe injection practices can be overcome only by bringing about a change in the behavior of healthcare workers and patients, by ensuring availability of equipments and supplies and by managing the waste generated appropriately and safely.<sup>4</sup>

For more information visit the Safe Injection Global Network website: [www.injectionsafety.org](http://www.injectionsafety.org)

### Slide 18: Exposure hazards

The use of radiation sources in medical and other applications is widespread throughout the world. Occasionally, the public is exposed to radioactive waste (usually originating from radiotherapy treatments) that has been disposed off improperly. Serious accidents have been documented in Goiânia, Brazil in 1988 where four people died from acute radiation syndrome and 28 suffered serious radiation burns. Similar accidents happened in Mexico City in 1962; Algeria in 1978; Morocco in 1983 and Ciudad Juárez, Mexico in 1983.<sup>5</sup>

### Slide 21: Mercury

Mercury is used in medical equipment and in dental amalgams. It is a neuro- and nephro-toxic substance. It affects the nervous system and can impair the way we talk, hear, see, walk, feel and think. Humans are exposed to mercury through contaminated air, water or food, or directly through the skin.

In the case of mercury spills, personnel get exposed and they do not have the capacity to handle either the spill or the exposure. World over, there is a shift to products which do not use mercury. For details refer to the slides on mercury in the Training

section.

### Case Studies

Three children, ranging from 20 months to six years, were exposed to mercury from a thermometer spilt on the carpet. They developed symptoms of sensitivity to light, weight loss, sweating and scaling palms, eczema and itching. The two more severely affected required four months of therapy for a complete recovery.

In another instance, 1.1 gram of mercury collected from a broken thermometer was collected in a pan and placed over a hot stove. Two elderly patients, who were exposed to the resulting mercury vapours, developed severe pulmonary edema, confusion, tremors and coma and died after seven and 17 days of hospitalisation, respectively.

### Slide 22: Glutaraldehyde

Glutaraldehyde is a potent skin irritant and sensitizer. Exposure to it is a recognised cause of occupational asthma. People may be needlessly exposed to glutaraldehyde vapours in a patient's room. Glutaraldehyde, along with many other disinfectants and chemicals, needs to be handled carefully to minimise health hazard.

### Slides 23 to 25: Salient features of the rules and associated rules

The section on Rules gives a detailed account of the Indian legislation on this issue. However, these slides touch on some salient features of the rules. The last slide highlights the fact that a hospital generates many different types of waste. For effective waste management the hospital would have to follow several legislations and guidelines, including the Solid Waste Rule, Atomic Energy Act and Hazardous Waste Rules and E-waste Rules.

The other Acts that a hospital would need to

→ 5. WHO Information Fact Sheet No. 253, October 2000.

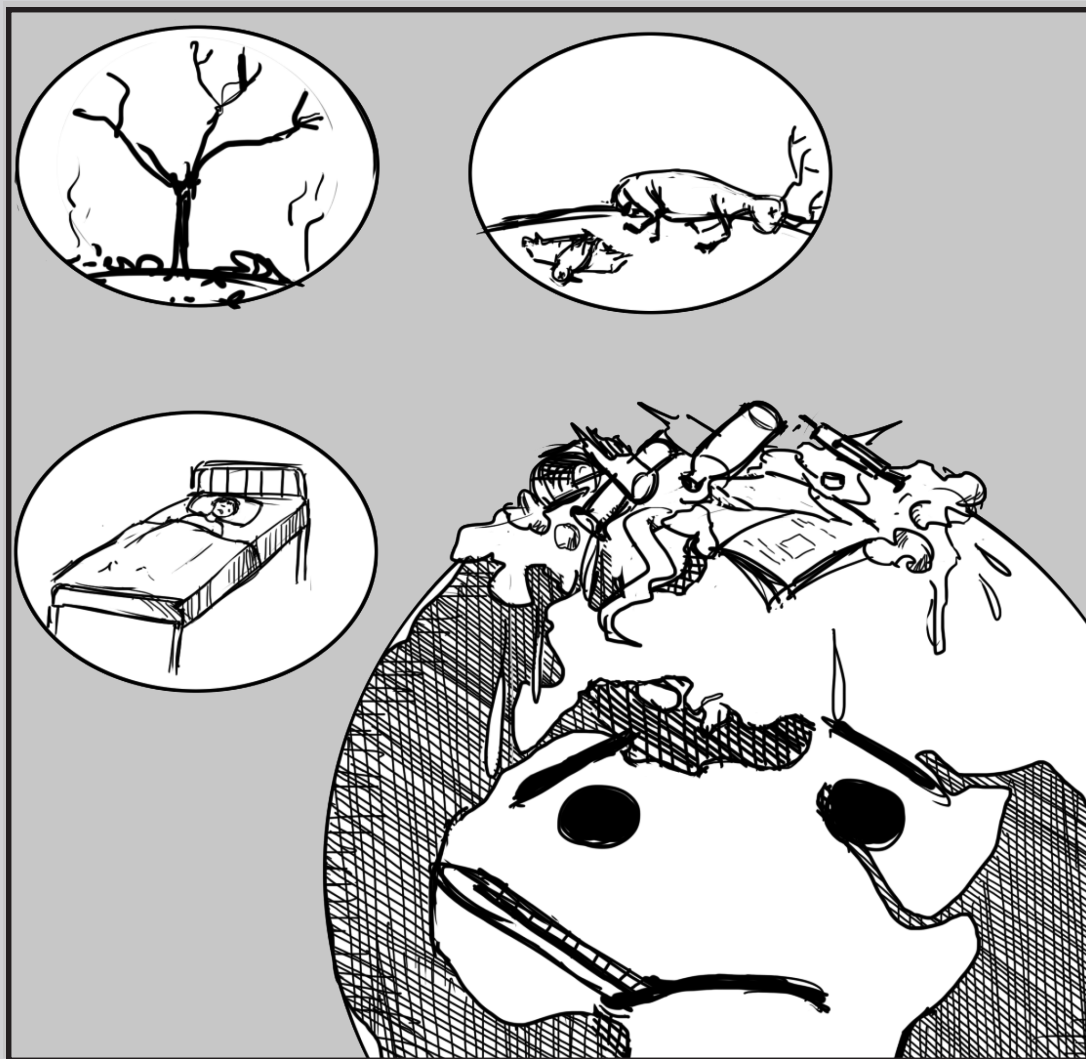


adhere to include the Water and the Air Act.



# *Section B*

## **Bio medical waste management: An environment and health paradigm**



# B1 Bio medical waste management: An environment and health paradigm

## Slide 2

Bio-medical waste management started with the need to protect local communities from spread of infections and later became an issue of global significance. Earlier, segregation of waste was all that was expected from the hospitals but now this is just the primary goal for them. In the new environmental paradigm, they are expected to evolve to secondary and then tertiary issues.

Persistent Organic Pollutants (POPs) released during medical waste incineration (one of the source) has become so important that WHO and all other UN agencies are trying to promote non-burn technologies and look forward to projects demonstrating decreased emission of POPs.

To control mercury emissions including the ones from healthcare measuring instruments, CFLs etc. Minamata Convention was signed by many countries in the world including India.

Many NGOs around the world have got together to fight global pollution. Health Care Without Harm, is a coalition working for sustainable hospitals. They have done great work with almost all aspects of hospital functioning (<https://noharm.org/>).

Global Alliance for Incineration Alternative has been advocating the use of incinerator alternatives. They have run many successful campaigns, policy work and community awareness programmes.

## Slide 4

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted in 1989. It was in response to a public outcry following the discovery of deposits of toxic wastes in developing world which was imported from abroad. This import was triggered by increasing cost and social awakening on disposal of hazardous toxic waste in the developed countries.

It was against this background that the Basel Convention was negotiated in the late 1980s, and its thrust at the time of its adoption was to combat the “toxic trade”, as it was termed. It was adopted in 1989 and entered into force in 1992.

Relevance to BMW and global significance

The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes, which includes clinical waste produced from the healthcare sector. The provisions of the Convention center around the following principal aims:

- ◆ the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- ◆ the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of

environmentally sound management; and

ANNEX I of the convention (which lists categories of wastes to be controlled) lists, Clinical wastes from medical care in hospitals, medical centers and clinics (Y1) and Waste pharmaceuticals, drugs and medicines (Y3), as two of the categories.

<http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx>

## Slide 5

### Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of humans and wildlife, and have harmful impacts on human health or on the environment. Given their long range transport, no one government acting alone can protect its citizens or its environment from POPs. Exposure to Persistent Organic Pollutants (POPs) can lead to serious health effects including certain cancers, endocrine disruption, birth defects, dysfunctional immune and reproductive systems, greater susceptibility to disease and damages to the central and peripheral nervous systems.

In response to this global problem, the Stockholm Convention, which was adopted in 2001 and entered into force in 2004, requires its parties to take measures to eliminate or reduce the release of POPs into the environment.

<http://chm.pops.int/TheConvention/Overview/tabid/3351/>

### Status of compliance in India

India signed the Stockholm Convention in May 2002 and ratified it in 2006. Indian Rules are against onsite (decentralized) waste treatment and

favour centralized treatment facilities. Decentralised systems are allowed only if the service of common biomedical waste treatment facility is not available at a distance of seventy-five kilometer. The new rules call for a phase out of use of chlorinated plastic bags, gloves and blood bags within two years from the date of notification of the rules.

The new Rules have set in standards for total Dioxins and Furan release at 0.1ngTEQ/Nm<sup>3</sup> (at 11% O<sub>2</sub>) (Sample duration- 8 hours or 5Nm<sup>3</sup> of sample volume, whichever is more). They require that the incinerator be upgraded within two years to meet these standards. Also the residence time of waste in the secondary chamber has been changed from 1 sec to 2 seconds.

The rules focus and stress on segregation of waste at source and recycling of plastic medical waste.

Medical waste contains a high proportion of polyvinyl chloride (PVC), a chlorinated plastic that is used in containers for blood, catheters, tubing and numerous other applications. When burned, PVC releases polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (dioxins), a family of 210 persistent organic pollutants that are unintentionally formed and released from a number of industrial and incineration processes, including medical waste incineration, as a result of incomplete combustion or chemical reactions.

An assessment of small-scale medical waste incinerators in developing countries showed widespread deficiencies in the design, construction, siting, operation and management of these units. These deficiencies often result in poor incinerator performance, for example, low temperatures, incomplete waste destruction, and inappropriate ash disposal and dioxin emissions, which can be even 40,000 times higher than the emission limits established by the Stockholm Convention. They may also release significant amounts of other

hazardous pollutants through gaseous emissions, fly and bottom ash, and occasionally through wastewater. Such pollutants include heavy metals (such as arsenic, cadmium, mercury and lead), acid gases, carbon monoxide and polycyclic aromatic hydrocarbons (PAHs).

The sole purpose of sharing this information with the trainees is that when they casually throw a plastic bag/ tubing in an incinerator, they should remember the amount of dioxins and furans which would be released into the air. Our country has a moral obligation to reduce emissions of POPs, and the country is made of us.

## **Slide 7**

### **Minamata Convention**

Article 4 of the treaty talks about Mercury-added products:

Each Party shall not allow, by taking appropriate measures, the manufacture, import or export of mercury-added products listed in Part I of Annex A (which includes thermometers and sphygmomanometers) after the phase-out date specified for those products i.e. 2020. Each Party shall take measures for the mercury-added products listed in Part II (includes dental amalgam) of Annex A in accordance with the provisions set out therein.

#### **Annex A, Part I: Products subject to Article 4, paragraph 1**

Mercury-added products: Phase-out date- 2020 (Date after which the manufacture/ import/ export of the product shall not be allowed)

The following non-electronic measuring devices except non-electronic measuring devices installed in large-scale equipment or those used for high precision measurement, where no suitable mercury-free alternative is available: (a) barometers; (b)

hygrometers; (c) manometers; (d) thermometers; (e) sphygmomanometers.

### **Annex A, Part II: Products subject to Article 4, paragraph 3 Mercury added products Dental amalgam**

#### **Provisions**

Measures to be taken by a Party to phase down the use of dental amalgam shall take into account the Party's domestic circumstances and relevant international guidance and shall include two or more of the measures from the following list: (i) Setting national objectives aiming at dental caries prevention and health promotion, thereby minimizing the need for dental restoration; (ii) Setting national objectives aiming at minimizing its use; (iii) Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration; (iv) Promoting research and development of quality mercury-free materials for dental restoration; (v) Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices; (vi) Discouraging insurance policies and Programmes that favour dental amalgam use over mercury-free dental restoration; (vii) Encouraging insurance policies and programmes that favour the use of quality alternatives to dental amalgam for dental restoration; (viii) Restricting the use of dental amalgam to its encapsulated form; (ix) Promoting the use of best environmental practices in dental facilities to reduce releases of mercury and mercury compounds to water and land.

[http://www.mercuryconvention.org/Portals/11/documents/conventionText/Minamata%20Convention%20on%20Mercury\\_e.pdf](http://www.mercuryconvention.org/Portals/11/documents/conventionText/Minamata%20Convention%20on%20Mercury_e.pdf)

India is a signatory to the treaty and the treaty

talks about a phase out of mercury medical instruments by 2020 and phase down of dental amalgam. Thus, India would have to seriously consider taking steps to reduce the use of mercury in the healthcare sector.

### **India on the larger mercury front:**

The mercury containing lamps have now been included in the revised E waste regulation. Now Extended Producer Responsibility (EPR) will be applicable to the disposal of mercury containing Lamps. Stringent mercury dosing standard has been placed for the mercury containing lamps, eg 2.5 mg for CFL upto 30 Watt. As far as one of the largest consumers of mercury, the chlor alkali sector is concerned; India has 35 Chlor Alkali plants in operation. Out of these, 32 have shifted to mercury free alternative technology and 3 plants are still using mercury cell technology.

## **Slide 9**

### **Patient safety**

Patient safety is the prevention of any harm to a patient during the process of health care. In October 2004, WHO launched a patient safety programme in response to a World Health Assembly Resolution (2002) urging WHO and Member States to pay the closest possible attention to the problem of patient safety.

Over the past ten years, patient safety has been increasingly recognized as an issue of global importance.

- ◆ Patient safety is a serious global public health issue. Estimates show that in developed countries as many as one in 10 patients is harmed while receiving hospital care.
- ◆ Of every hundred hospitalized patients at any given time, 7 in developed and 10 in developing countries will acquire health care-associated

infections. Hundreds of millions of patients are affected by this worldwide each year.

[http://www.who.int/features/factfiles/patient\\_safety/en/](http://www.who.int/features/factfiles/patient_safety/en/)

To tackle this problem, the World Alliance for Patient Safety is implementing a multifaceted strategy in areas like-

- ◆ Blood products and their use;
- ◆ Injection practices and immunization;
- ◆ Safe water, basic sanitation, and waste management;
- ◆ Clinical procedures, particularly in first-level, emergency care

### **Injection practices and immunization**

Around 16 billion injections are administered each year in developing and transitional countries. One needle stick injury from a needle used on an infected source patient carries an average risk of transmitting HBV, HCV, and HIV of 30%, 1.8%, and 0.3%, respectively. In 2000, contaminated syringes caused 21.7 million hepatitis B virus infections (33% of all new infections), 2 million hepatitis C infections (40% of all new infections), and 260 000 HIV infections (5% of all new infections).

INCLIN study (2002-2004) pointed out that 2/3 of all injections are administered in unsafe manner in India, which is a big number. GoI has introduced Auto disable syringes for immunization and curative purpose in the central government. Such practices need to be adopted by all states.

### **Waste management**

Safe disposal of waste in healthcare, in particular syringe, needles or infectious body fluids, protects healthcare workers and the community from

infections, toxic effects, and injuries. Education and hand washing promotion can lead to more than a 50% reduction of the disease burden and save lives in children under 5 years of age in low-income populations.

[http://www.ijidonline.com/article/S1201-9712\(06\)00125-1/fulltext](http://www.ijidonline.com/article/S1201-9712(06)00125-1/fulltext)

According to the Director General Health services, GOI, some of the priorities areas for our country are-

- 1) Safe clinical practices and hand hygiene
- 2) Safe Surgical practices
- 3) Blood Safety
- 4) Safe Injections Practices
- 5) Health Care Waste Management Rules and guidelines

The government has given a lot of importance to medical waste management. Though the rules and guidelines are available but implementation is very poor. Lack of training or poor training is also a factor. It has not been given the due priority by most of the states and dedicated budget is not available.

<http://nabh.co/Images/PDF/patientsafety.pdf>



# *Section C*

## **Implementing a waste management system in a hospital**



# C1 Implementing a waste management system in a hospital

## Slide 1 and 2: Project plan

The person in charge of setting up the waste management system in the hospital would need to be well-versed with the entire functioning of the hospital.

The minutest detail of the hospital's processes would need to be looked into as they may be useful through the course of work. For example, a hospital's layout can be useful while one is working out the transportation route within and outside the hospital. Even while planning the location of bins, linen storage sites, final storage sites, or deciding on the trolley requirements (size and manoeuvrability), one has to take into account the passage design and dimensions.

A survey of the existing practices is important as it:

- ◆ Lays down the basic framework and methodology of work and has bearing on the inputs required;
- ◆ Provides some discussion points during the training sessions;
- ◆ Gives an insight into the awareness level of the staff and their attitudes;
- ◆ Makes one familiar with the hospital set up and helps strategy planning.

## Waste survey

- ◆ Helps in deciding the type, size and placement of bins.
- ◆ Helps in identifying specific needs. The need of waste survey is discussed in greater detail in Slide 8.

A waste survey helps in deciding the right kind of material required for managing waste. Ordering for the right kind of bins, etc., required for waste management is important. These things should be ordered before starting the training of the staff. A hospital may not be always be able to decide what kind of equipment it needs. In that case it can initially choose a Model Ward and set up a waste management prototype system there. Different equipment, bins and bags, etc., can be tested in this ward, and then, the most suitable kind can be selected for the entire hospital.

## Slide 2: Project plan, stage II

The second stage would involve training and implementation of the waste management system in the hospital. In this phase, the Model Ward can be duplicated in the entire hospital.

Ongoing training is very important because a hospital's staff turnover rate is generally very high. Moreover, the subject may lose its importance over a period of time. It is important therefore to keep reminding the staff about waste management issues

till the concepts are ingrained into the system.

Monitoring is very essential in the early stages of the system. Continuous monitoring in the early stages helps establish the system and subsequent monitoring helps in its upkeep. Monitoring would involve inspecting segregation, disinfection and mutilation of waste in the wards, use of protective gear, route and means of transportation, final treatment and disposal of waste, etc. It primarily covers all the aspects of waste management and takes a close look at waste from the cradle to the grave.

Monitoring each and every aspect of waste management in the entire hospital at one time is difficult. Monitoring should thus be done in a layered manner.

Primary monitoring can be done by the nurse incharge of the ward during her morning rounds. Her daily reporting formats should include waste management. The floor incharge can take up issues like transportation of waste and checking the ward nurses. The nursing superintendent can make rounds once in a while and make the floor incharges accountable for waste mismanagement on their floors. The nursing superintendent could report to the medical superintendent and the director, one of whom can be the head of the waste management committee.

This system would ensure that the waste management committee is not burdened with the task of monitoring the entire hospital. They could make their presence felt at some locations each day through surprise visits.

*In the Holy Family Hospital, monitoring by seniors helped in building and strengthening waste management practices.*

## **Slide 4: Waste management commit-**

**tee**

It is important to set up a waste management committee because one needs to have some nodal people who will look after waste management and be responsible for it. As per the BMW Rules 2016, hospital above 30 beds must have a waste management committee

Preferably headed by the institute's head as per the BMW Rules 2016, hospital above 30 beds must have a waste management committee.

In case of hospitals below 30 beds, a qualified person must be designated to monitor the hospital's waste management system. The waste management committee should meet atleast once in six months and recordings of the meeting must be shared with the prescribed authority as per Bio-Medical Waste Management Rules, 2016.

The committee should comprise of people from all hierarchal levels and its members should be carefully selected to have a good, energetic and committed team. Amongst them one or two nodal people (depending on the size of the facility) can have waste management as their key responsibility.

The committee's responsibilities would include the reviewing and monitoring of Bio medical waste management in the hospital, training of staff and scheduling training programmes. The committee would also look into the legal requirements of the system – from getting authorisation to maintaining annual records regarding waste management.

## **Slide 5: Waste management policy**

The waste management policy should address all important aspects of waste management. It should be clearly laid down and be available in writing. This not only brings clarity in the working place but also provides a scope for further improvement.

All hospital personnel should be handed over a

summary of the waste policy and their role in the whole chain. This would help in fixing responsibilities. Personnel can also be motivated to suggest improvements in the policy after their practical experience in waste management.

The policy needs to be reviewed periodically and any new standards and regulations from the implementing authorities and suggestions from the staff should be included to make it effective.

### **Slide 6: Occupational safety and health**

In India, occupational safety has always figured low in the priority of employers. This situation needs to be changed, especially in hazardous sectors.

The hazards in a hospital environment include the transmission of infections through needle-stick injuries, blood splashes and body fluid spills, mercury poisoning and other chemical exposures.

A group of experts should identify problem areas and find ways of minimising worker exposure. Work involving hazards should be done by the fewest possible number of personnel, and this work should be rotated so that the level of exposure to each individual is minimised. The entire staff of a healthcare facility must be immunised for protection against diseases including Hepatitis B (mandatory) and tetanus (SOS) as they are likely to be transmitted during handling of Bio Medical Waste.

### **Slide 7: Why do a waste audit?**

A waste audit is the complete survey of a hospital's waste management practices. One can either do a survey by visiting each department and ward (to weigh and analyse the composition of waste) or one can get all the waste bags labelled and analyse them at a central location. The first method gives an advantage of getting to know the hospital and its personnel better (for an external survey agency)

while the second method offers the benefit of speed.

For insights into the consumption pattern of the hospital and ways of reducing the waste stream, one needs to go to the stores, pharmacy and the users (nurses and doctors) and explore the possibility of changing the consumption patterns. Over-packaging, high wastage due to over-use or excess procurement and ordering in smaller packs are some areas which can be looked into. BMW Rules, 2016 have made it mandatory for the hospital to update the records of waste audit on its website. The hospitals are given a time of 2 years (from the date of notification of the Rules) to make a website in case they do not have one.

### **Slide 8: Setting up a Model Ward in the hospital**

The concept of a Model Ward is helpful in a large set up where the cost of establishing a waste management system is high. One ward or department in the hospital can be chosen and the staff of that ward area can be trained to set up a 'pilot' waste management system.

Different kinds of equipment, bins, bags or any other material can be tested in this model ward and can then be selected for the entire hospital. This not only helps in having a demonstration site within the hospital for trainees, but also helps decide the best possible equipment through feedback from the staff. Thus, it makes good economic sense.

### **Slide 9: Components of hospital waste management**

After the waste survey is completed and the Model Ward is in place, one can start setting up a waste management system in the hospital.

The first step in this process is training. The entire hospital staff needs to be adequately trained. The details about training are covered in a separate

section. At this point it is important to discuss experiences and experiments with regard to training methodologies in hospitals.

Training can be done by going to various wards/departments and speaking with nurses at their workstations so that they understand things practically. This method takes a lot of time and also makes the sessions less serious at times because the nurses are generally busy with their patients and leave the sessions intermittently.

The second method is the seminar/lecture approach. All the personnel work in shifts, thus it is necessary to work out a timetable according to the shift and involve the entire staff. This not only ensures that each person in the hospital has been trained but also saves time and brings a focus to the training sessions.

While the staff is being trained, the equipment required for waste management should be made available at their workstations so that they can start practicing what they have learnt.

## Slide 10: Segregation

Segregation refers to the storing of waste in separate containers. It is the most important aspect of Bio-Medical Waste Management Rules, 2016.

The rules specify different categories of waste, the materials that comprise those categories, the prescribed colour codes for them and the type of treatment technology for each of them.

There are 4 categories of waste specified in the rules and all the waste found in wards can be sorted into these categories.

Segregation of waste is always done at the point of its generation and as soon as it is generated. Doing it elsewhere, or delaying the process, would result in mixing of waste (that is, contaminating the entire waste stream) and will thus defeat the purpose of

segregation.

Segregation not only reduces the chances of spreading infection, but also prevents occupational hazards (since only limited waste needs special handling and a responsible person with all protective gear and resources can handle it for the entire hospital). Segregation also reduces the investment in waste disposal. Since 80 per cent of a hospital's waste is general waste, it does not require special treatment, provided it is not contaminated with other infectious waste. If everything is mixed, the hospital would have to treat the entire waste and would spend up to five times the cost of treating only infectious waste.

## Slide 11: Segregation: Make a difference

Segregation should be done in accordance with the rules. Hospital staff should be briefed about the rules. Posters can be put up on walls near the bins or any other suitable place to continuously remind the staff about their responsibilities.

Several things affect the degree of segregation:

- ◆ All bins should be preferably easy to use, in terms of their design and placement. There are instances when mixing of waste was directly linked to the poor access of one particular bin. All decisions regarding bins (their number, placement, etc.) should be taken in consultation with the personnel.
- ◆ The number of each bin type should be optimised. As each bin directly translates into a liner (bag), economically it makes sense to use bins intelligently. In case of bag usage, one can eliminate the use of black bags meant for general waste in case only dry waste is reaching the bin. The bins and bags should be of the same size to minimise wastage.
- ◆ The bins should be kept clean and should be

covered and foot-pressed. This will eliminate the hesitation to approach a bin due to its appearance.

### Slide 13: Collection

Waste management does not stop at segregation – it only begins with it. Everyone down the line has to contribute to make the system effective and sustainable.

House keeping staff should be trained to collect and transport waste in a responsible manner, so that there is minimal risk of exposure – to themselves and to others. They should be warned against mixing, spilling or mishandling the waste. They should be told about the contingency measures in case of accidents/spills and the method of reporting these. Designating different people for different waste introduces some specialisation into waste management. Specialisation, in this case, refers to the collection of one particular hazardous waste from the entire hospital by one person (this can be done in rotation). This has the advantage of bringing in a system of accountability (one man is answerable for that waste) and safety.

Different waste streams should be collected at different times. This reduces the chances of mixing. It also avoids wastage of bags, for example, general waste needs to be collected frequently, while the other bags do not. The time of collection for each type of waste would also depend on the time of its maximum use. In hospitals, mornings generally begin with dressings and other such activities, and the yellow bags meant for such waste are filled up in the morning shift. Thus, noon is a good time for collection of this waste. A similar ‘timing’ strategy can be adopted for all types of waste according to the hospital set up.

Closed containers not only offer an aesthetic advantage, but are also much safer in cases of accidents (to minimise spillage).

### Slide 14: Storage

Storage time is the time lag between the generation of waste and its treatment. Storage could be of different kinds: storage of waste within the hospital’s wards/departments; storage outside wards but within the hospital premises; if the waste is taken to a treatment site, then storage in a vehicle; and finally storage at the central facility.

According to the Indian rules, waste should not be kept untreated for more than 48 hours. One must remember that this is the maximum time limit. Keeping the Indian climate in mind (the hot and humid conditions in most parts of the country) it is advisable to treat waste as soon as possible.

According to WHO, unless a refrigerated storage room is available, storage times for healthcare waste (i.e. the delay between production and treatment) should not exceed the following:

- ◆ Temperate climate: 72 hours in winter; 48 hours in summer.
- ◆ Warm climate: 48 hours during the cool season; 24 hours during the hot season

Storage within the hospital should be done in labelled, colour-coded bins and bags in secured, balanced, easily washable containers that do not have any sharp edges.

The main storage site of the hospital should be accessible to vehicles so that the collection vans can reach it. This reduces the number of personnel handling the waste. The storage site should have a smooth surface so that it can be washed easily in case of spills. The hospital should ensure that there are written instructions to handle spills, and that the personnel at the storage site are trained for such work.

### Slide 17: Special cases

Some places like operation theatres, ICUs and emergency wards have a different style of working. These places therefore need special attention. People from these areas need to be consulted to optimise the system of waste collection so as to suit their requirements while not compromising on waste management.

### Slide 18: Monitoring

A waste survey should be done before, and after, implementing a waste management system. The comparative analysis can be presented in a hospital meeting and the entire staff can be shown the economic and environment benefits of waste management. This would encourage them to continue the waste management practice. One can, as an example, document the decrease in accident rates related to waste disposal, or demonstrate the decreased cost in the treatment of waste, revenue earned by selling recyclables, etc.

A waste survey also helps in pin-pointing areas of extra usage and wasted products. The hospital can concentrate on waste segregation in the initial stages and can, later, move on to waste minimisation. Monitoring ensures that the system continues and the chain is never broken. Monitoring should be done by all the senior staff of the hospital and all check lists should have it as one of the criteria of evaluation.

### Slide 19: Keep score

It is very important to monitor the waste management system once it is in place. Monitoring would highlight area-specific problems which can be discussed, and sorted out, with concerned personnel.

It is important to conduct routine Waste Audits to be able to spot any increase in infectious waste or fluctuations in waste generation. These changes could be evaluated by the hospital administration.

### Slide 24: Economics of waste management

Economic factors play a major role while setting up a waste management system. The attempt should always be to have the best system with minimum investment.

In our hospitals we keep a track of the expenditure on the system and possible ways of reduction of the same on a continuing basis. In our observation, a centralised facility turns out much cheaper than on-site facilities. The quality of plastic bags should be upto the mark and as per the Plastic Waste Rules. As per new BMW Rules, chlorinated plastics must be phased out within 2 years of notification of the rules. Several other things influence costing and should be studied carefully.

### Slide 26: Lessons learnt

Waste management involves many personnel and requires a good degree of financial management. One can come across ego problems, apathy and indifference during the implementation of such a system. One needs to be patient and remember that waste management is a new concept. Till now, it has not been a priority, and has often been seen as a liability. Things do change after a few weeks and the staff tends to get involved as they see results.

A large time interval between training and the placement of equipment nullifies the impact of training.

## Implementing a waste management system in a hospital



# Reducing Carbon Footprint of a Health care Facility



# D1 Reducing Carbon Footprint of a Health care Facility

## Slide 2

### Carbon footprint of a Health care Facility

Each and every activity we undertake has a carbon footprint, however; with our intellect and planning we can minimize these. Hospitals are considered big energy, water and chemical guzzlers. It is very important that this sector works out ways to holistically heal itself with respect to the environment.

A healthcare facility with a dental wing (with bed size of 300 -500) not using mercury alternates can reduce mercury emissions in the environment by 3kgs/year. Similarly a 700 bedded hospital with good waste management policies can cut down its green house gas emissions by almost 1300 MTCO<sub>2</sub> equivalent.

## Slide 3

### Estimated plastic Bio-medical waste generated in India

India's medical sector would end up saving - 272,132 MTCO<sub>2</sub> E emissions in the environment, by recycling its plastics rather than incinerating it. (This is an underestimate because it does not account for a lot of plastic used on OPD patients).

Many technology proponents have time and again proposed methods where one can forego segregation, which is cited as inconvenient and cumbersome. These technologies mix the entire waste, treat it chemically/ by other methods, shred it and then landfill the entire mix. *Choosing recycling rather than land filling option has major economic gains, saving -124,237 MTCO<sub>2</sub>E emissions/year.* Thus recycling emerges as the best viable option for management of plastics generated in the hospital.

Similarly glass, cardboard, paper and metal waste is sold to recyclers to get revenues for the hospital and at the same time minimizes the footprints of the hospital. Recycling a ton of paper saves about 24 trees, which absorb 250 pounds of carbon dioxide from the air each year. Various practices like going paper less on requisitions, leave forms, office memos and notices; shredding and sending confidential documents for recycling (post shredding) can save a lot of paper.

One ton of recycled plastic saves 16.3 barrels (685gallons) of oil, 98 million Btus of energy and 30 cubic yards of landfill space (Mississippi Department of Environmental Quality). Recycling a ton of plastic also saves about as much energy as is stored in 197 gallons of gasoline (Ohio Department of Natural Resources).

## Slide 4

### Calculating Carbon Footprints for Waste Management

Considering a 700 bedded hospital which generates- 2.5 kg/bed/day municipal waste, 208 gms/bed/day autoclavable waste and 297 gms/bed/day incinerable waste (which comes to 83%, 7% and 10% respectively).

Judicious waste management by the hospital would lead to, **1300 MTCO<sub>2</sub> E reduction** in a year.

There is a web based calculator on the USEPA site which helps you calculate your carbon footprints wrt waste. It takes the baseline scenario and compares it with an alternative scenario and calculates the emission reduction/ increase due to the changed practices.

[https://www3.epa.gov/warm/Warm\\_Form.html](https://www3.epa.gov/warm/Warm_Form.html)

For eg:

Baseline scenario- The hospital mixes everything and throws its waste in the municipal dump from where it is land filled.

Alternative scenario- All general waste is segregated according to the type of material (plastic, cardboard, newspaper, office paper, aluminium foil, tin, cans, wet waste etc.) and given for recycling/ composting. The bio-medical waste plastic is also segregated, disinfected, mutilated and sent for recycling.

To estimate the carbon footprint, note down the amount of waste produced by the hospital in about 2-3 months for baseline as well as the alternate scenario and take an average for both the scenarios. Once we feed the figures of all the waste generated (plastic, tin, paper, etc.), the calculator works out the footprints. Like-

- ◆ GHG Emissions from Baseline Waste Management Scenario (MTCO<sub>2</sub> E): 491
- ◆ GHG Emissions from Alternative Waste Management Scenario (MTCO<sub>2</sub>E): -809
- ◆ Total Change in GHG Emissions (MTCO<sub>2</sub>E): -1,300 (Alternative- baseline)

Note: These calculations have not accounted for the source reduction and waste minimization drive of the hospital.

As the new BMW Rules (2016) have made it compulsory for the hospitals to send all their waste to the CTFs. Maybe now the CTFs can be prompted to start such practices.

## Slide 5

Reducing Carbon footprints through waste segregation

A hospital can minimize its carbon footprints by following few simple steps:

1. Work on the training of its staff to achieve appropriate and maximum segregation.
2. Minimize yellow bag waste and ensure that only the things specified to go into the incineration, are sent there.
3. Recycle all the recyclable waste after appropriate disinfection.
4. Ensure decentralized management of municipal waste – by segregating the waste at source into biodegradable and recyclable. Also, this waste can be treated by adopting procedures like composting and recycling.

5. Minimize generation of toxic and hazardous waste and managing such waste through authorized recyclers.

6. Reduce packaging waste, substitute toxic chemicals use reusable where possible and develop a green purchasing policy.

## Slide 6

### Reduction of energy consumption

Health care in America, including activities such as hospital care, scientific research and the production and distribution of pharmaceutical drugs, was found to produce 8 percent of the country's total carbon dioxide output despite of accounting for 16 percent of the U.S. gross domestic product.

#### Sir Ganga Ram Hospital, New Delhi

To promote energy saving and conservation of resources, the hospital has made an Energy Management Policy and communicated it to all employees so as to encourage their involvement through training and participation. To achieve reduction in energy, following measures have been adopted: Installation of Solar Water Heating System in new buildings. Installation of VFD in Pumps of Laundry and Water Treatment Plants. Regulating the hours of lighting in various buildings. Installing capacitor bank thereby maintaining power factor at 0.99 on continuous basis.

Replacing ordinary lights with CFL / electronic blasts, centralized AC Plant for old building and solar Water Heating System of around 30,000 LPD in the hospital have been installed. This has led to energy savings of 932,500 (kWh) and th932,500 (kWh) is translates into 670MT of carbon dioxide emissions saved/year.

## Slide 7

### Reduction of water consumption

Hospitals and other healthcare facilities are significant users of water. Reducing water use can lead to major savings in terms of lower water and sewer bills.

According to the Indian standard code of basic requirements for water supply, drainage and sanitation, hospitals below the bed strength of 100 and above 100 respectively have the water allotment of 350litres /day and 450 l/d per bed respectively <https://law.resource.org/pub/in/bis/S03/is.1172.1993.html>

Hospitals that have conducted successful water use reduction programs have been able to reduce water use by approximately 20 to 30%. However, to achieve such dramatic savings requires a systematic approach. Recommended steps include:

- ◆ **Audit current water use.** Install water meters at strategic locations in the facility. Read/record water readings weekly (or more frequently at first) and analyze the data. Look for high water use areas, trends, and unusual occurrences.
- ◆ **Identify water conservation opportunities,** including low hanging fruit (drips, leaks and unnecessary flows), changes to operations (e.g., improved practices in cleaning, laundry and kitchen), and opportunities requiring engineering/equipment solutions (toilets, sterilizers, boiler, chillers, etc.).
- ◆ **Determine cost** of opportunities **and potential return** on investment.
- ◆ **Prioritize** water conservation opportunities.
- ◆ **Develop a phased plan** that fits your budget.

◆ *Implement plan.*

◆ *Measure and document success*

## Slide 8

### Circular economy w.r.t. Bio-medical waste management

Unlike the traditional linear economic model based on a 'take-make-consume-throw away' pattern, a circular economy is based on use, reuse, repair, refurbish and recycle, in an (almost) closed loop, where products and the materials they contain are highly valued. In practice, it implies reducing waste to a minimum.

The USEPA estimated that 75% of the American waste stream was recyclable, but they only recycle about 30% of it. Similarly EU nations which have very strict segregation policies are able to recycle just near 50% of their waste. In all these countries policies and public pressure groups are aiming at making SEGREGATION better to increase recycling, so that the circular economy dream is fulfilled.

<https://www.dosomething.org/us/facts/11-facts-about-recycling>

In India, waste pickers try to collect some recyclables. A study found that the informal recycling sector in Delhi alone accounts for estimated net GHG reductions of 962,133 metric tons of carbon dioxide equivalent (TCO<sub>2e</sub>) each year. This equates roughly to removing 176,215 passenger vehicles from the roads annually or providing electricity to about 133,444 homes for one year (US estimates).

[http://www.chintanindia.org/documents/research\\_and\\_reports/chintan\\_report\\_cooling\\_agents.pdf](http://www.chintanindia.org/documents/research_and_reports/chintan_report_cooling_agents.pdf)

## Slide 9

### Green purchasing

Buying products with reduced environmental and human health impacts is vital to sustainable health care. Environmentally Preferable Purchasing (EPP) is the act of purchasing products/services whose environmental impacts have been considered and found to be less damaging to the environment and human health when compared to competing products/services. Implementing green procurement does not feature benefits only for the environment but also for financial aspects, and can lead to financial savings; this can be justified using Life Cycle Assessment.

A clear and simple policy statement on EPP from top managers shows that senior management is committed and provides a framework indicating which of the EPP goals the institution wants to achieve. In order to make sure the policy is a living document and not just words on paper it is crucial that the purchasing team not only understands the integration of environmental issues into the purchasing process, but is made up from people with a passion for the ecological and health benefits of EPP.

<https://practicegreenhealth.org/topics/epp>

## Slide 10

### Stockholm County Council PVC Elimination Policy –

Stockholm County Council (SCC) passed a resolution to phase out PVC in 1997. The program prohibits the use of PVC unless a very strong, written explanation for its necessity is provided as part of the purchasing process. PVC has been virtually phased out from many disposable medical products, including IV bags and tubing, drainage and urine bags, catheters and feeding

tubes. Although there are no legal restrictions on the use of DEHP [Bis (2-ethylhexyl) phthalate], SCC hospitals make efforts to avoid DEHP-softened tubing for use with small children. For example, at 32 neonatology units in the country, feeding tubes used for the long-term treatment of babies are made of non-PVC materials. If there are no PVC-free alternatives that fulfill all the criteria, Karolinska Hospital (one of the hospitals under SCC jurisdiction) purchases DEHP free devices in the interim period before safer and affordable PVC-free alternatives reaches the market.

The Broadgreen University Hospitals NHS Trust (RLBUH), worked with Mölnlycke Health Care (a supplier of surgical devices) to create a series of procedure packs which could be used across all theatres. This moved away from individually supplied and wrapped items to 21 specially designed pre-prepared packs containing the core items required for a given procedure. As a result of introducing procedure packs the Trust has almost halved the set up time per operation which has led to its theatres being used more efficiently. The procedure packs also improved consistency for items used during procedures, and has simplified stock management and the reordering process. This is again saving staff time. The packs have also helped to reduce packaging, the value of stock holding, stock shrinkage.

Carbon and Financial Savings- Taking simple action by increasing the use of theatre packs has resulted in the Trust saving £175,000 per year (based on staff time saving). It's also reduced the volume of associated packaging waste by 90% (around 2.6 tonnes) helping the Trust to reduce its carbon footprint by five tonnes.

<http://www.sduhealth.org.uk/areas-of-focus/commissioning-and-procurement/procurement/case-studies.aspx>

## Slide 11

### Hospital waste management

**1. Non-medical or general waste** –A hospital produces both medical and non-medical waste. The non-medical waste constitutes about 80% of the total waste stream. These non-medical waste should be segregated at the point of generation and managed according to the Solid Waste Management Rules 2016.

<http://www.moef.gov.in/sites/default/files/SWM%202016.pdf>

Thus the segregation plan for Kitchen and canteen, where only non-medical waste is generated-

White Bin- For recyclable waste

Green Bin- For bio-degradable waste

In the wards where mostly recyclable general waste is generated white bags can be considered for sorting and storing recyclable Solid waste .

**2. Bio-medical waste-** Around 15-20% hospital waste is Bio-medical waste. Within this waste stream, different categories of Health care units have different waste composition. Generally, 45% of BMW is found recyclable whereas 55% is found non-recyclable. However in case of bedded HCUs, proportion of soiled waste is more and proportion of recyclable waste is only 40% of total BMW generated (out of which around 30% is composed of IV fluid bottles)

**3. E-Waste-** This waste has to be managed according to the e-waste (Management & Handling) Rules 2016, which say, consumers or bulk consumers (*hospitals would qualify under this category*) shall ensure that e-waste generated by them is channelized to authorized collection centre or registered dismantler or

recycler or is returned to the pick-up or take-back services provided by the producer. (list of CPCB Approved recyclers.

<http://www.cpcb.nic.in/divisionsofheadoffice/hwmd/e-Waste.pdf>

#### **4. Mercury waste-**

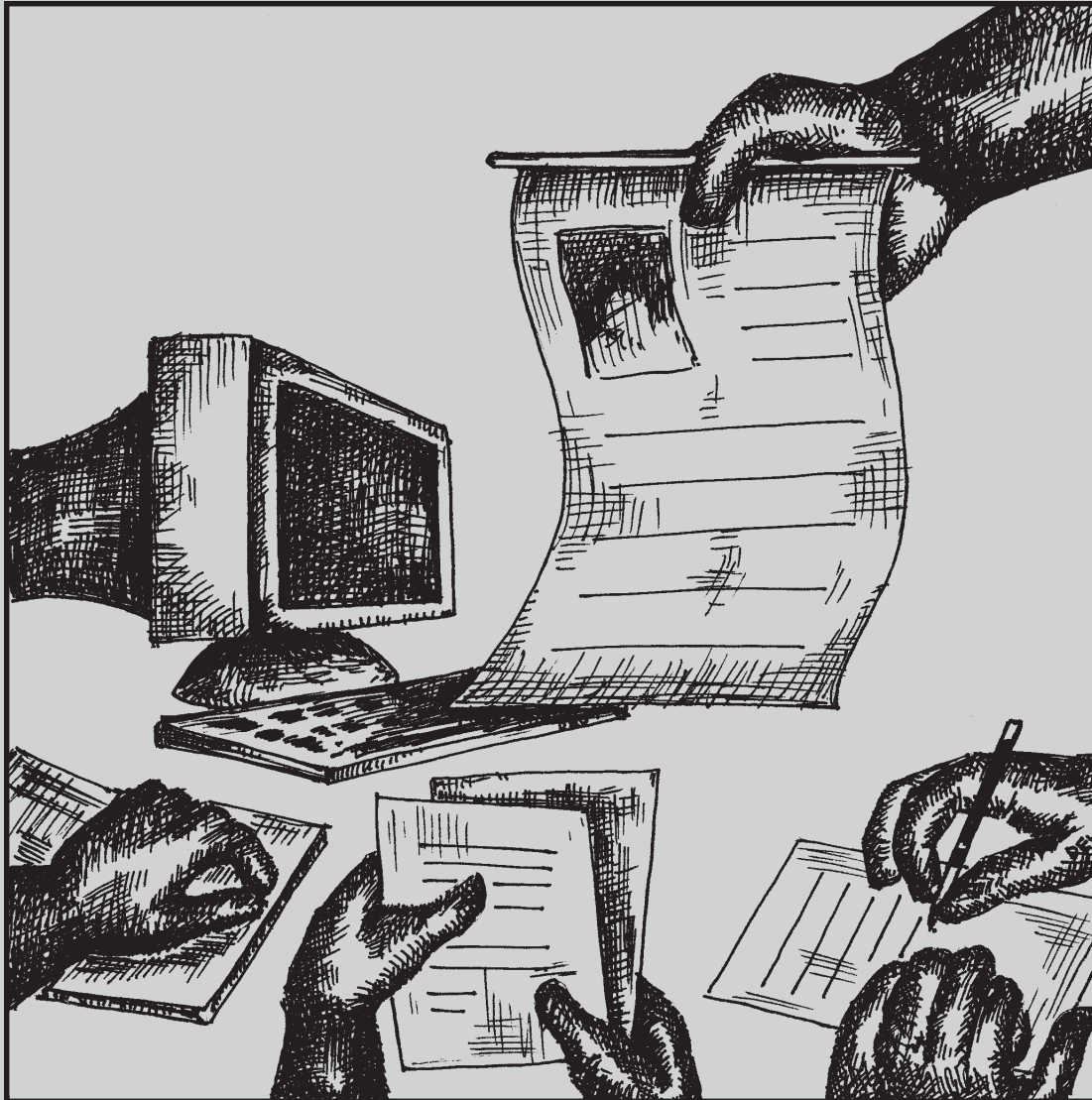
Refer section E (Training hospital staff)





# *Section E*

## **Training hospital staff**



# E1 Training hospital staff

**T**raining and creating awareness amongst the hospital staff is the key to having a good waste management system. It not only appries them of the existing problems and the need of managing waste but also orients them to a practical system.

Training can be done in a particular ward initially where a model system could be established. This ward/ department can be used in further training sessions as a practical model for trainees and can further be replicated in the entire hospital.

## Slide 1: Who requires training?

A chain is as strong as its weakest link. Thus, not a single person in the hospital should be missed out while training is imparted. Waste management requires the involvement of the entire hospital staff in some form or the other. Administrators, store personnel and other seemingly uninvolved departments also require training to ensure that the waste is carried responsibly from the cradle to the grave.

In order to ensure that all waste is segregated and safely transported, and that the material required for waste management is available to the staff, it is important to involve everyone, including doctors, administrators, nurses, technicians, ward boys and safai karamcharis.

The sessions for different groups should be taken separately, as different ideas need to be stressed upon for each category.

## Slide 2: Trainers

**Initially, training can be done by**

◆ A hospital staff member: a staff member who is well-versed in the subject should take the training sessions. Care should be taken that his/her regular duties are considered while deciding the time of the training sessions.

◆ An outside agency: an outside agency with a proven track record can also be asked to train the staff.

Ongoing training can be carried out under the auspices of the Waste Management Committee, Infection Control Committee, or by the medical/nursing/sanitary superintendents for their respective staff.

## Slide 3: Training sessions

Training covers the following aspects: sensitisation, teaching(dissemination), discussion and feedback.

The first session is devoted to sensitising the audience on the need to manage waste in the hospital. In the second session, the audience is made aware of various aspects of hospital waste management – segregation, disinfection, etc. The last session is taken only after the trainees have implemented the scheme for about one to two weeks in their respective areas. They are asked about the problems that they have faced during the implementation of the programme.

Training sessions should be lively; they may start on a formal note but should be made informal, and one should try to make them interactive at all stages.

Training modules should include equipment and other materials to be used later by the staff for waste management. Slides on various aspects of waste

management (including efforts by a hospital already following the system), health effects of mismanagement of waste, etc., help a lot in making the message more powerful.

## Medium of training

As far as possible, all training modules should be in the vernacular medium, or the language in which the staff is most comfortable.

## Demonstrations

Demonstrations and live acts help in making the training sessions interesting and therefore making trainees understand things faster.

## Ongoing training

This is one of the most important components of training. Generally, a hospital's staff turnover rate is quite high. Ongoing training, besides being a continuous reminder for the older staff, ensures that the new staff is aware of the issues. Also the new rules, 2016, has made a provision of continuous trainings. Training should be conducted at the time of induction and thereafter once a year. This helps in sustaining the system.

## Slide 4

### Session 1

It is imperative to tell trainees why a particular thing needs to be done. Once its importance is realised, people are motivated to make an extra effort to do it. The first session is therefore generally devoted to sensitising trainees about waste management issues by telling them about the problems associated with mismanaged hospital waste.

Initially, one can get inputs from the trainees about waste management practices in their hospital. It is always good to involve trainees by asking them specific questions about what happens to different

types of waste, what they think constitutes the major chunk of the waste, and how they think they can help in minimising the waste. Before one begins telling them about waste mismanagement and related problems, probing into the risk perception results in a healthy discussion.

## Slide 5: Sensitisation – the need for managing waste

### Dangers to the patients

The immune system of our body protects us from external infections. People with weak immune systems are prone to infections. With organ transplants becoming common, hospitals may have patients with suppressed immune systems due to use of steroids (intentional suppression to avoid rejection of a transplant). Moreover, there are many drugs whose side effects include suppression of the immune system. In all these cases it is evident that in a hospital, there is a higher probability to find people with lowered immune response who can easily pick up an infection.

### Dangers to the community through bio-medical waste

Spread of infection through waste: According to various surveys and reports, of the total waste generated by hospitals only 10-15 per cent is infectious and needs treatment. The rest of it falls under the category of general waste which does not need any treatment. If all the waste is mixed, the entire waste generated by a hospital becomes infected. As the quantity of waste to be treated increases, the hospital fails to treat all its waste and a large chunk of this infectious waste reaches municipal dumps, and increases the possibility of spreading infection.

Municipal waste is rich in organic material and, at times, remains uncollected for days together. This gives pathogens the time to multiply. Municipal dumps are also frequented by animals and birds

that can carry various pathogens proliferating in the dump. Thus municipal dumps should be kept free from any infectious or hazardous waste.

### Problems due to incinerators

Incineration of waste is linked with the formation and release of acid gases, heavy metals, dioxins and furans.

Acid gases include nitrogen oxide, which forms acid rain and affects the respiratory and cardiovascular system.

Heavy metals are released during incineration of medical waste. Mercury vapourises on incineration and spreads easily in the environment. Lead and cadmium, which are highly toxic heavy metals, are also present in certain plastics. Dioxins and furans are released and get accumulated in the ash when plastic and some other waste containing these metals is burnt. Incineration is thus a hazard not just for the hospital staff, but also for the community.

Dioxins and furans are organochlorines, which form as a result of the combination of organic material with chlorine molecules in plastics (for example, PVC). Organochlorines mimic hormones and thus disrupt the hormonal cascades. They are proven carcinogens and endocrine disrupters, and also weaken the immune system and damage the male and female reproductive organs.

### Spread of infection through recycling

A lot of disposable items like syringes and I.V. bottles re-enter the market and reach the hospitals. This increases the risk of spreading infection in the community through the ragpicker who collects it, the person who repacks it, the nurse who opens it and finally the patient who uses it. Thus, it is the duty of the nurse or the person involved in the treatment of the patient to ensure that disposables used in patient care are mutilated immediately to prevent their reuse.

### Some facts about reuse of sharps

- ◆ It is estimated that over 30 per cent of the estimated 12 billion injections administered worldwide are done so in an unsafe manner, posing serious health risks to health workers, their patients, and the community;
- ◆ Reusable syringes are not properly sterilised before use;
- ◆ Disposable, one-time-only syringes are used more than once;
- ◆ Used syringes are not disposed off properly;
- ◆ Hepatitis B Virus (HBV) can survive in a syringe, in dry conditions for seven to eight days.

### Slide 6: Dangers to healthcare workers

Hours spent at the workplace: healthcare workers spend a major part of their day in hospitals. Any problem here would affect them the most.

All the points in this slide are discussed in greater detail in the following slides.

### Slide 7: What are sharps?

Our rules define sharps as anything capable of causing cuts or punctures, including used and unused material.

Needle-stick injuries: Skin is our primary protective barrier and sharps have the ability to penetrate it. Thus a needle-stick injury, which is able to establish blood-to-blood contact, has a very high rate of transmitting infections.

The greatest occupational risk for transmitting a blood-borne infection is through parenteral exposure – by a penetrating sharps injury – sustained from an infected person.

(Note: Detailed slides on needle-stick injuries are provided in the Occupational Safety section).

## Slide 8: Categories of staff exposed to needle-stick

There are several published papers where researchers have tried to document the incidence of needlestick injury in various categories of hospital staff. As all these studies are in different hospital settings the percentages and the actual figures may vary with each paper.

OSHA estimates that 5.6 million workers in the healthcare industry, and related occupations, are at risk of occupational exposure to bloodborne pathogens, including HIV, hepatitis B virus (HBV), hepatitis C virus (HCV) and others. According to the CDC, in March 2000, it was estimated that 600,000 - 800,000 needlestick and other percutaneous injuries occur annually among healthcare workers.

Studies also show that nurses sustain the majority of these injuries.

## Slide 9: Incidents leading to needlestick injuries

Many researchers have tried to figure out the situations and use of any particular equipment, which makes people more prone to needle-stick injury. It has been found that that as many as one-third of all sharps injuries are related to the disposal process. Thus, a good sharps management programme within the hospital can greatly improve safety.

## Slide 10: Sero-conversion following exposure

Sero-conversion means the percentage of healthcare workers developing the infection after being exposed to body fluids from a proven infective source. These rates have been documented by carrying out a follow-up of healthcare workers with

occupational exposure to blood from a patient positive for a particular blood-borne pathogen. For instance, in the case of exposure to a HIV positive patient, the healthcare worker would be tested for HIV antibodies at the time of exposure (baseline testing) and at periodic intervals for around 12 months.

### Potential risk factors for sero-conversion following percutaneous injury:

- ◆ Interval between needle use and exposure.
- ◆ Depth or severity of exposure: deeper injuries lead to more blood transfer, thus increasing the probability of infection transmission.
- ◆ Quantity of blood injected: this is directly related to virus particles passed to the person. At least 0.1 ml of blood is thought to be required to cause infection in case of HIV, whereas for HBV which is much sturdier than HIV and whose circulating titer is also high, it is estimated that 0.00004 ml of blood may be enough to cause an infection as a result of needle-stick injury.
- ◆ Bore of needle: studies have suggested that more blood is transferred by deeper injuries and by hollow bore phlebotomy needles, especially those of larger gauges than with solid suture needles.
- ◆ Source patient: a patient's clinical status or stage of disease and the drug therapy he/she is receiving would affect the virus titer in blood thus influencing sero-conversion.
- ◆ Clinical status.
- ◆ Titer of circulating virus: the titer of freely circulating virus in the blood greatly influences the sero-conversion rate. For example, the quantity of infectious virus in plasma or serum of HIV infected individuals is estimated to be 10-15 infectious particles (ip)/ ml with the

highest levels of  $10^4$ ip/ml in patients with AIDS.

A small amount of freely circulating virus in the blood could explain the low risk of infection following a needle-stick injury compared to that of HBV, which is present in infected individuals at  $10^9$ ip/ml. In other body fluids like tears, saliva and ear secretions the virus titer is one-tenth or one-hundredth of the titer in blood.

- ◆ Use of antiviral drugs/vaccination: use of antiviral drugs like zidovudine after exposure to HIV and inoculation of vaccination following a HBV exposure have proved helpful in preventing sero-conversion in most cases. Research evidence seems to suggest that the use of anti-HIV drugs like zidovudine in combination with other anti-HIV drugs if given soon after the injury can reduce the rate of transmission. It is recommended that Post Exposure Prophylaxis (PEP) should commence within 24-36 hours of injury; preferably within a few hours of exposure.
- ◆ Healthcare worker: the immune response, adoption of universal precautions and post prophylaxis affect the susceptibility of the healthcare worker.
- ◆ Use of barriers: use of personal protective equipment, like gloves, may help reduce sero-conversion. Studies have shown that a single pair of surgical gloves appears to decrease the volume of blood injected by solid suture needle by 70 per cent or more in almost every simulation. Two pairs of gloves may reduce it by another 50 per cent, or more.<sup>1</sup>

There are a small number of instances when HIV has been acquired through contact with mucous membranes or non-intact skin (If intact skin is exposed to HIV infected blood, there is no risk of HIV transmission). Research suggests that the risk

of HIV infection after mucous membrane exposure (for example, splashes of infected blood in the eye, is much less than one in 1,000). If muco-cutaneous exposure occurs, wash the affected area thoroughly with soap and water. If the eye is affected, irrigate thoroughly.

Given this backdrop, the importance of all types of protective gear is paramount.

In 1995, the Center for Disease Control (CDC), USA, estimated that 800 healthcare workers were infected with the hepatitis B virus. This figure represented a 88.3 per cent decline from the 6,800 infections estimated in 1992. Immunisation programmes with the hepatitis B vaccine and the use of universal precautions were responsible for the decline.

## Slide 11: Mercury products

Mercury is found in various types of equipment, predominantly thermometers and sphygmomanometers. Other mercury-based instruments likely to be found in the hospital are barometers, oxygen and foetal monitors, esophageal dilators, etc.

Other than instruments, mercury can be found in laboratory chemicals like mercuric chloride, Zenker's solution, mercury oxide, some fixatives like B5, Schaudinn's fixative, and dental amalgams.

Dental amalgams are a mixture of mercury, (approximately 50 per cent metallic mercury by weight) silver, copper and tin which quickly hardens together into a solid form. Mercury in dental amalgam is not in a stable form and it is well documented that mercury vapour is released from dental fillings.

## Why is there a shift from mercury products?

There is now an International treaty designed to protect human health and the environment from

→ 1. Bloodborne occupational diseases of healthcare workers, PRIA and ACILS.

anthropogenic emissions and releases of mercury and mercury compounds. It targets mercury use across all sectors like- healthcare, gold mining, lighting etc. India is one of the signatories of Minamata Convention. The treaty talks about the phase out of mercury medical instruments by 2020 and phase down of dental amalgam. India has to seriously consider taking steps to reduce the use of mercury in the healthcare sector and as Mercury free alternatives are available and are being adopted in a number of states and healthcare facilities (For eg: DGHS (MoH); States- Delhi, Punjab, Manipur; Hubli Dharwar municipality have issued mercury phase out orders). A number of factors restrain people from using them viz. their relatively high initial costs and doubts over their accuracy.

This skepticism has been proved wrong by various studies. Alternative technologies are not only accurate but are also easier to use; in addition they offer cost benefits in the long term. Their adoption by certain institutions set an example that India is ready to take the step to become Mercury Free.

India is working towards mercury phase out from health care sector. States like Delhi, Punjab and Manipur have released mercury phase out orders for medical equipments in the Health care sector. In, 2010, Directorate General of Health Services (DGHS, MOH) released the Guidelines asking healthcare facilities to phase out the use of mercury instruments and dispose their waste in an environmentally sound manner. The Central Pollution Control Board issued 'The Mercury Storage Guidelines' in 2011 [http://www.cpcb.nic.in/Guidelines\\_for\\_ESM\\_%20MercuryW\\_fromHCFs.pdf](http://www.cpcb.nic.in/Guidelines_for_ESM_%20MercuryW_fromHCFs.pdf) and these guidelines ask for proper management of mercury waste generated from the healthcare sector (mercury waste arising due to spillage / breakage/ phase out of mercury instruments and the dental amalgam waste). Thus the hospitals should develop a strategy to phase out the use of mercury instruments and then dispose the mercury waste

safely. The recently proposed amendments to the BMW Rules also include a section on proper management of mercury spillage in hospitals.

<http://toxicslink.org/?q=content/bmw-guide-lessons-bio-medical-waste-management>

Sir Ganga Ram hospital drafted a mercury policy and decided to implement the programme in two phases. In the rst phase mercury thermometers were phased out. Also in the dental wing 80% of the restorations were switched to mercury alternatives. The hospital then implemented the second phase in which the sphygmomanometers were replaced with aneroid units. The hospital also held mercury awareness campaigns for the staff. Over 3000 nursing staff was trained on mercury spill prevention and management.

The hospital received ISO 14,000 and NABH Certification both of which required the hospital to curtail the use of these hazardous substances in the hospital. The hospital is now successfully mercury free. The hospital was one of the first five hospitals in Delhi which announced that they would go mercury free voluntarily, without a mandate from the government. Though Mercury free alternatives are being adopted but there is a well established need of standardising these instruments. Toxics Link is now working on standardization of these instruments to help in complete phase out of mercury instruments.

A study in an elderly population evaluated the differences in the self-recording of blood pressure with automatic and semi-automatic equipment, using a mercury sphygmomanometer by a physician as a 'gold standard' control. The findings indicated that there was no difference between the mercury and alternative methods of blood pressure measurement. Interestingly, they found significant differences when the semi-automatic system was used. This was thought to be related to errors made by the patient while measuring the blood pressure; several patients could not inflate the cuff.



Mercury sphygmomanometers are limited by factors such as observer bias which confound the ability to discern the true blood pressure value. On the other hand, automated blood pressure machines demonstrate less within-subject variability during repeated measures than mercury sphygmomanometers. Hourly blood pressure profiles recorded through 24 hours by automated and manual methods from hypertensive patients were nearly identical. These data suggest that blood pressure measured by auscultatory automated methods are similar to, and representative of, those obtained manually.

### Slide 13: Effects of mercury

Mercury is the only heavy metal that can exist in all three states of matter: it readily changes from solid to liquid to gaseous form and is a persistent bio-accumulative toxin. It circulates constantly in the environment. Three major forms of chemical mercury circulate in the atmosphere: mercury (0), mercury (II) and methyl mercury. Methyl mercury can accumulate in muscle tissue and bio-magnify via the food chain.

Mercury is a neurotoxicant and affects the brain and the nervous system. Other vital organs like kidneys and lungs are also affected. Mercury poisoning can be difficult to diagnose since the symptoms are common to other afflictions.

### Dangers associated with mercury spills

Some micro-organisms have the ability to change elemental mercury to methyl mercury, which is easily absorbed by all life forms. Mercury not only passes the skin and the blood-brain barrier, but also the placental barrier. Pregnant women and children are most vulnerable to the effects of mercury. A foetus exposed to mercury shows nervous system damage. The Minamata disaster in Japan is an example of mercury poisoning.

Human exposure can happen through consumption of mercury-contaminated food (especially fish) and water. Inhalation of mercury vapour and penetration of liquid mercury through the skin from dental amalgams are other routes of exposure.

The half-life of mercury, or the time needed to excrete half of a dose to which one is exposed is 44 to 80 days. Mercury is excreted via faeces, urine and breast milk.

### Slide 14, 15: Where is glutaraldehyde used ?

Glutaraldehyde is a broad-spectrum germicide; it is non-corrosive, and non-flammable. Because it can remain stable under certain conditions over several days, it has the potential for re-use. Its high material compatibility and property of acting synergistically with other disinfectants makes it very popular. That is one of the reasons why it has not been phased out despite its health impacts on workers. However, strict regulations have been put on its use.

Glutaraldehyde has a pungent odour and its odour threshold is fairly low (0.04 ppm). It can sensitise the respiratory system. The sensitisation can be long-term or permanent in certain cases, and that can create problems for people in certain professions. It can also cause contact dermatitis, which is why it is strongly recommended that people who work with it never let it come into contact with their skin. The hands and forearms are most likely to be affected by splashes of glutaraldehyde liquid. Vesicular dermatitis consists of redness and tiny pinprick blisters that may burst to create areas of weeping.

Studies have shown that people who work in healthcare settings where there is regular exposure to glutaraldehyde are much more likely to develop allergic reactions. Rhinorrhoea, or runny nose, is an early sign of the irritant effects on the airway.



In normal use there may be complaints of sore eyes, presumably due to vapour exposure. In the case of splashes, animal experiments have shown that if the eye is not irrigated to remove glutaraldehyde, permanent corneal damage can occur. Contact lens wearers should have their lenses removed by ophthalmic staff.

Asthma: this is the most serious of the possible adverse health effects. Sensitisation can occur many years after the first exposure and once sensitised, reactions can occur when exposed to minute airborne concentrations.

Glutaraldehyde can be damaging to the environment because it is a very potent disinfectant. It can kill bacteria or the ecological microbial flora. For this reason, a system that uses a septic tank can have problems disposing off huge amounts of glutaraldehyde. Its fixative property kills germs, but this can be a bit of a disadvantage too. If some medical devices or environmental surfaces are not pre-cleaned properly then the organic matter can become very rigidly fixed to their surfaces. If glutaraldehyde from medical devices is not washed well before they are used on a patient, any residue that subsequently comes out during its use can be damaging to the tissue.

A number of regulatory agencies in Canada and USA, as well as in Australia and UK, have reviewed the permissible limits of glutaraldehyde. The general trend is to reduce the allowable limits of glutaraldehyde in air to a lower level. For example, in several jurisdictions the permissible level will go down from the earlier limit of 0.2 ppm to 0.05 ppm.

Alternatives to glutaraldehyde are available and are based on peracetic acid, ortho-phthalaldehyde, hydrogen peroxide, superoxidised water, and gas plasma systems.

## Slide 16: Cytotoxic drugs

Adverse health effects from both acute and chronic exposures to cytotoxic drugs have been demonstrated in healthcare personnel.

Over a long term, almost all of these drugs have the potential of damaging cells or adversely affecting cellular growth and reproduction. The drugs bind directly to genetic material in the cell nucleus, or affect cellular protein synthesis.

In-vivo, in-vitro and human studies have implicated anti-neoplastic drugs in chromosomal damage, teratogenesis, and carcinogenesis. Testicular and ovarian dysfunction, including permanent sterility, have been demonstrated in male and female patients, respectively, who have received these drugs singly, or in combination. Studies in Finland have shown an increased incidence of foetal loss among nurses routinely working with anti-neoplastic agents than among those who do not. Other studies have suggested a correlation between exposure to anti-neoplastic agents and foetal malformation in pregnant nurses.

Additionally, organ damage has been associated with exposure to some anti-neoplastic agents. Liver damage has been reported in oncology employees, and appears to be related to the duration and the concentration of the exposure.

The risks to workers handling anti-neoplastic agents are a result of the inherent toxicity of the drugs themselves, and the actual dose that a worker receives. The dose is dependent on the concentration of the drug, the duration of the exposure, and the route of entry.

The adverse health effects as a result of exposure to a particular drug may depend on whether the drug enters the body through inhalation, through the skin, or ingestion. In order to ensure occupational safety while handling Cytotoxic drugs, ICMR in collaboration with AIIMS and Toxics Link is working on the development of **“National**

## **Guidelines on the Use of Anticancer Drugs”.**

### **Slide 18: Dangers to ragpickers**

Lot of young children get involved in the business of waste-sorting to look for recyclables to supplement the income of their families. They frequent municipal waste dumps, which have municipal waste mixed with some component of infectious and hazardous waste. Various studies have documented the exposure of these children to infectious medical waste. A study with 152 rag-picker children handling hospital waste, found the mean age to be 13.2 (+/-2.1) years. Almost one-third of the ragpickers were married. All of them were handling infectious waste with their bare hands. None of them had ever used gloves and all of them moved around in waste heaps in bare feet, without any protective boots or shoes. Almost 80 per cent of them had evidence of skin infections and/or injuries on their hands and feet.

Protective barriers such as protective gear (gloves, boots), immunisation, antiviral, etc, which are known to reduce the possibility of transmission of infection following a needle prick, are unknown to these people. With the potential of sero-conversion following needle-stick injuries and the exposure of the mucous membrane to blood and other body fluids it is not difficult to imagine the health status of these children who are always amidst needles, infectious bandages, blood and urine bags, etc.

### **The new legislation for medical waste**

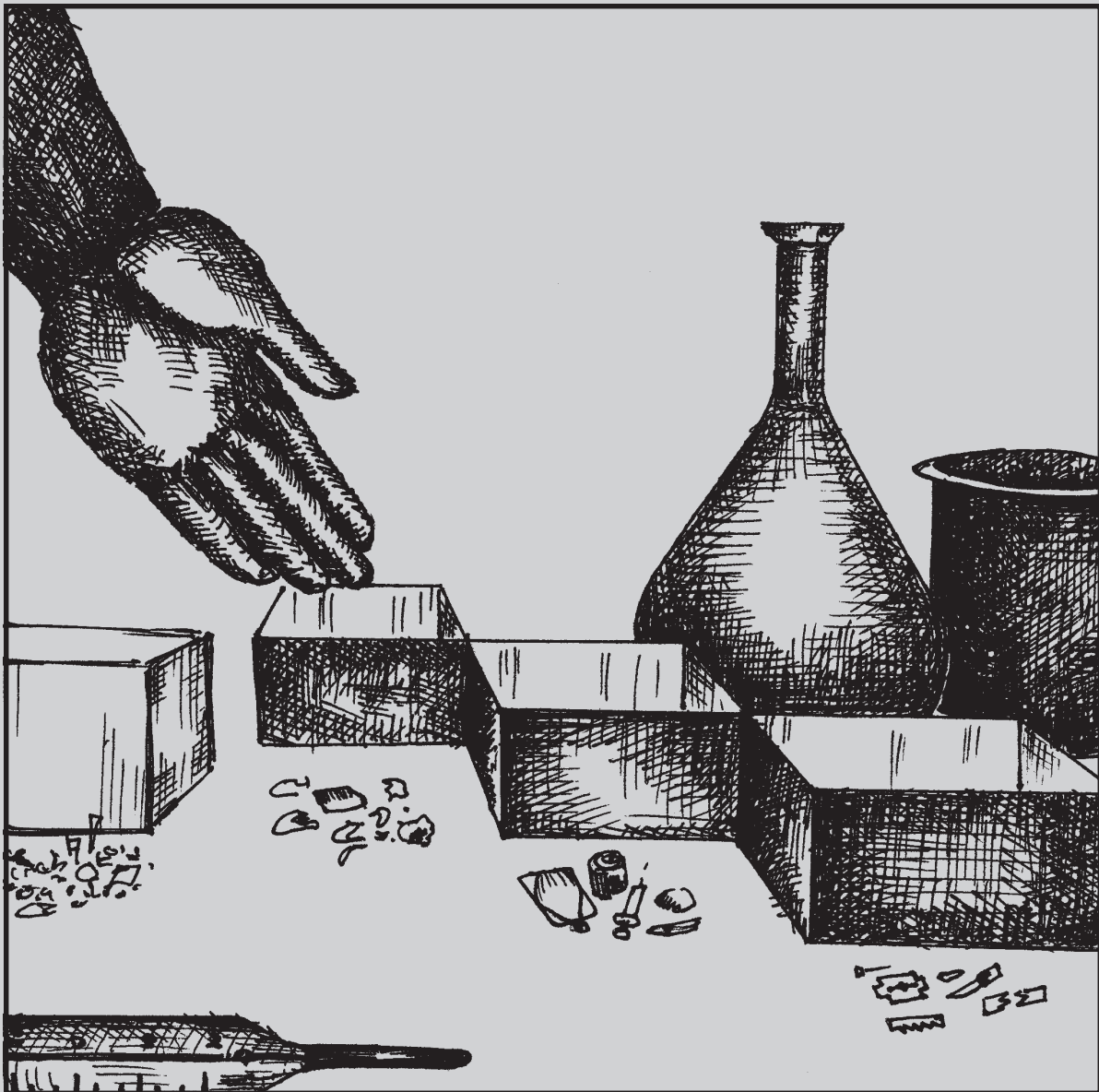
The entire hospital team needs to know about the provisions of the Bio-medical Waste Management Rules, 2016. The reasons of how and why these came into existence should be explained so that they appreciate the usefulness of this legislation. It must also be impressed upon them that much effort would be needed from their side to make a waste management programme succeed.

The clauses regarding fines and other legal

implications should also be dwelt upon. The trainees must know that the rules have been made under the Environment Protection Act, 1986 and under this Act the onus of non-compliance lies not only on the owner/head of the area/institute, but also on the officer incharge of the particular department where the problem has been spotted. Others present at the time of negligence are also accountable.

# *Section F*

## **Aspects of waste management**



# F1 Aspects of waste management

**T**his session focuses on managing different kinds of bio-medical waste such as chemicals, sharps and cytotoxic material. It presents specific suggestions and methods for dealing with each category of waste.

This section requires a fair degree of practical demonstrations. Any new equipment, bins, etc., that would be introduced in the wards for waste management should be shown and their use explained to all personnel during the training sessions.

## Slide 2: Categories and colour codes

The Bio-medical Waste Management Rules, 2016 carry instructions regarding segregation of waste (depending on its type) in differently coloured containers. The rules describe the categories of waste, the colour codes to be used for them and the treatment options for each type of waste.

Schedule I of the rules (as shown in the slide) describes the various categories of waste and their treatment options. The schedule lists fourty categories of waste which can be generated in a hospital. All the hospitals may not generate all types of waste. Even big hospitals, which generate all categories of the listed waste, would generate them at specific locations in the hospital, and not in the entire hospital.

## Slide 5: Waste segregation system

Four categories have been designated for medical waste according to the colour of the bin: Red, Yellow, Blue and White. An explanation of the colour codes, and the type of waste that falls under each code is given below:

### Yellow

This colour has been recommended for waste that can be burnt. It includes human and animal waste, soiled waste; expired discarded medicines; chemical waste; chemical liquid waste, linen, mattresses etc. contaminated with blood/body fluid, pre treated microbiological, biotechnological and other clinical laboratory waste. The final disposal/treatment option for yellow category waste is Incineration/Plasma pyrolysis or deep burial. Deep burial is only allowed in rural/remote areas where there is no availability of a Common Bio medical waste treatment facility (CBWTF). For human/anatomical waste only these 3 treatment options should be adopted, however for other types of waste in this category, other treatment options are mentioned.

**Note: Suitable disposal/treatment technology is mentioned for Cytotoxic Drugs**

### Red

Red coloured containers are meant for waste that is recyclable. The waste generated from disposable

items like tubes, bottles, gloves, catheters etc. this waste can be recycled and thus, autoclaving or microwaving or hydroclaving followed by shredding /mutilation is mentioned as the treatment technology.

## Blue

Blue containers have been recommended for the waste that can be disinfected. Glassware and metallic body implants with an exception of those contaminated with cytotoxic drugs comes under blue category. This waste is supposed to be disinfected before sending it for recycling. Blue cardboard boxes rather than plastic bags should be used for this category waste as to avoid any injury due to tearing of the plastic bag by broken glass material.

## White

White or translucent puncture proof bag is required for white category waste containing sharps viz. Needles, scalpels, blades, metal sharps etc. These should be autoclaved, mutilated or shredded before sending it to a landfill, sharp pit or any industry (after taking consent from SPCB).

**Note:** All the bags/containers used for collection of Bio medical waste should be made up of non chlorinated plastic.

## Slide 7: Segregation, making a difference

A successful waste management initiative hinges on segregation. By segregating the waste conscientiously the amount of waste that needs treatment is reduced drastically. It also leads to reduced costs for transporting and treating waste.

Yellow bags need to be placed in very limited areas, such as operation theaters, delivery rooms, and laboratories. Availability of all the colour bins at the required location will make segregation a handy task.

## Slide 8: Chemical disinfection

In the absence of disinfection technologies such as autoclave, microwave or hydroclave, waste should be chemically disinfected.

According to the rules, 1 per cent hypochlorite or any other equivalent reagent can be used for disinfecting. Chemical treatment must ensure disinfection. For this the Central Sterile Supply Department (CSSD) has to follow the supplier's directions closely.

Concentration of the disinfectant is critical to the process and dilution should be done accurately. Chlorine and alcohols are most rapid disinfectants and may be effective in two minutes if they have immediate access to bacteria. Phenolic disinfectants act more slowly. In the presence of organic material, 30 minutes contact may be necessary for effective action, while eight minutes are good enough on a clean surface.

Many disinfectants gradually deteriorate after dilution with water, thus, freshly prepared solutions should be used.

The Kelsey-Sykes test may be used to determine the effective concentrations of halogen disinfectants. Chemical estimation of available chlorine, expressed as a number of parts per million (ppm) can be used. For clean surfaces, which are totally free from organic material, a solution providing 100-200 ppm available chlorine is sufficient, but in the presence of organic material 1,000 ppm is recommended.

A chlorine disinfectant is the ideal choice when there is a possibility of a virus presence, in particular for disinfection of equipment soiled with blood. A higher concentration with 10,000 ppm available chlorine should be used in these conditions, due to the high level of inactivation by blood.

The concentrations, 100-200 ppm and 1,000 ppm

are referred to as weak and strong chlorine solutions, respectively, and can be prepared easily by diluting a concentrated hypochlorite solution or by dissolving available powders. However, an extra strong solution, with 10,000 ppm cannot be prepared from powders as it is difficult to dissolve the high amount of powder needed for this concentration.

### Slide 9: Cleaning up a body fluid spill

There are two seemingly paradoxical processes for disinfecting body fluid spills:

- ◆ Clean and disinfect
- ◆ Disinfect and clean

Body fluid that has been spilt on floors must be cleaned and then disinfected. To do this, cover the spill with absorbent cotton or a cloth. Discard this in the yellow container. Disinfect the surface with 10 per cent bleach for 10-15 minutes or use phenolic disinfectants.

A clear soluble phenolic disinfectant is a good choice for these situations because it is not seriously inactivated by the organic material and is compatible with an anionic detergent and soap.

The two-step process of cleaning first and disinfecting later gives better results as cleaning removes most of the organic material, which is known to inactivate disinfectants significantly. Cleaning first also exposes the micro-organism to disinfectants which may otherwise remain hidden in the soiling material.

This process is recommended for disinfection of surface or equipment where there is no risk of infection to the workers.

Where the staff is required to wash used equipment or glassware potentially contaminated by

pathogenic micro-organisms, the rule is to disinfect first and clean later. The glassware can be disinfected, washed and then disinfected again by heat treatment.

### Slides 10-14: Evolving sharps management

The hospitals should destroy the needles through needle cutters; put the cut syringes (without the needle) in the red bag and the needles to be put in white puncture proof containers. As sharps have been linked with the transmission of blood-borne pathogens, the hospital staff should be adequately trained to eliminate the risk of needle-stick injuries. Staff must be aware of acts or omissions likely to cause an accident.

The reporting of accidents is an integral part of successful management of sharps waste. Bio medical waste management rules, 2016 mention that all the accidents occurring while handling Bio medical waste should be reported in the annual report.

Some countries have made reporting mandatory. In UK, for instance, all employers are legally obliged by the Health and Safety at Work Act, 1974 to ensure that their employees are trained properly and are proficient in safe working practices.

Employers are also obliged by the Control of Substances Hazardous to Health Regulations, 1994, to review every procedure that involves contact with potentially dangerous substances, including bacteria and viruses in patients' blood and body fluids.

It is advantageous for the injured person to make a prompt record of any work-related accident so that an accurate account of events is available, if details are needed at a later stage.

In UK, the responsibility for reporting the injury

to the concerned authorities rests with the employer, as is also the case with Indian rules.

In India, an accident form is available which has to be filled by an individual in case of any injury (for eg: a needle stick injury). The injured staff should inform the concerned person at the earliest so that the source of contamination can be traced and infection (if, any) can be detected and appropriate remedial measures can be taken as soon as possible.

Trainee's queries on injuries and precautions should be answered with scientific data as far as possible. For example, during training sessions when Universal Precautions were being emphasised, nurses complained of getting needle-stick injuries even while wearing gloves and thus questioned its advantage. They were told about the study, which found that when a needlestick injury happens in presence of any barrier (such as a glove), the amount of inoculum (blood) reaching the body is reduced by 70 per cent and wearing two pairs reduces the risk further, thus reducing the chances of sero-conversion significantly.

## **The basics of safe practice when using sharps**

- ◆ Where possible, replace the use of sharps with other instruments or procedures;
- ◆ Used needles should never be recapped, bent or broken;
- ◆ Sharps should not be passed from hand to hand;
- ◆ All individuals have a personal responsibility to dispose of used sharps in a safe manner;
- ◆ Used sharps should be discarded into a sharps container as soon as possible;

- ◆ All the individuals should be using personal protective equipments.
- ◆ Sharps containers should be close to clinical areas but away from locations which may involve injury to patients, staff or visitors;
- ◆ Sharps containers should be securely closed when three-quarter full;
- ◆ The local policy regarding management of clinical waste must be strictly observed.

## **Suggested action following a needle-stick injury**

- ◆ Encourage bleeding at the site of injury: if percutaneous exposure occurs, bleeding should be encouraged by pressing around the site of the injury (but taking care not to press immediately on the injury site). It is best to do this under running water;
- ◆ Wash the wound with soap and hot water and dry the hands;
- ◆ Apply povidine-iodine to the wound;
- ◆ Cover the wound with an occlusive dressing (preferably water proof);
- ◆ Report the incident immediately to the person concerned/waste management committee;
- ◆ Fill in the accident form;
- ◆ Identify the source of needle contamination if possible.

## **Supplementary information**

More than 20 infections can be transmitted through needlesticks, involving viruses, bacteria, fungi, and other micro-organisms.



The diseases include: blastomycosis, brucellosis, cryptococcosis, diphtheria, cutaneous gonorrhoea, herpes, mycoplasma caviae, Rocky Mountain spotted fever, sporotrichosis, syphilis, toxoplasmosis, tuberculosis, malaria and mycobacteriosis. Many of these diseases are transmitted in rare events, but it still demonstrates that needle-stick injuries can have serious consequences.

During training sessions people should be convinced about the importance of reporting. Research findings suggest that all grades of hospital staff under-report sharps injuries. One study found that 53 per cent of the injuries were not reported on an accident form. The reasons for this are: a perception that the injury is not worth reporting; that reporting is too time consuming or inconvenient; a lack of awareness of the need to report the injury; and an inability to get to the employee health service.<sup>1</sup> Lack of time and the belief that there is a low risk of infection because of the involvement of a clean needle or a history of vaccination against hepatitis B have also been stated as reasons for staff failing to report a needle-stick injury.

A surveillance on healthcare workers who have been exposed to blood-borne viruses has been carried out since 1984 in UK. By the end of June 2000, the PHLS Communicable Disease Surveillance Centre had received 827 reports of exposures to material from patients with antibody to HIV, hepatitis C or hepatitis B. Of these, 242 workers were exposed to HIV. Of the total workers infected, 337 were nurses and 262 were doctors. These two groups remain the most frequently exposed.

Sharps waste in rural areas and immunisation settings is a big concern. In such situations the waste generation sources are scattered and the quantum of waste generated per location is little. Various options are being tried to manage this waste stream with minimum manipulation in the existing infrastructure and environment. See appendix (new policy paper)

→ 1. Under-reporting of needlestick injuries in a university hospital, Hamory B.H.

## Slide 15: Mercury spill management containment kit

A 'Mercury Containment Kit' should be available in all wards to clean up mercury spills. The kit should contain the following items:

- ◆ Nitrile gloves or two pairs of latex gloves (mercury can pass through a single pair of latex gloves), though chemical resistant gloves are ideal for the situation.
- ◆ Face mask
- ◆ Protection for the eyes
- ◆ Scotch tape
- ◆ 10 cc syringe
- ◆ Covered plastic/glass container with water

## Slide 16: Mercury spills – thumb rules

Mercury-based instruments should never be used in a carpeted area as recovering spilt mercury from carpets would be extremely difficult. If a mercury spill occurs, the following precautions should be followed:

- ◆ Never touch mercury with bare hands as mercury is absorbed quickly through the skin.
- ◆ Remove all jewellery when dealing with mercury, as mercury combines with gold, silver and other metals.
- ◆ Clear the area around the spill and contain the spread of mercury.
- ◆ Wear protective gear. Workers need to wear fit-tested respirators with chemical filters, not the ones they wear for biological risks. They need to, preferably, wear chemical resistant gloves,



and not latex gloves.

- ◆ Try to gather all the droplets of mercury with the help of two hard cardboard sheets and then use a syringe to suck this big droplet of mercury. Mercury is a non-wetting liquid, which has the affinity to hold to itself (a property called 'cohesion'); thus all small drops of mercury stick to each other to form a big drop.
- ◆ Pour contents of the syringe into a plastic/ glass container with 5-10 ml of water. Since mercury is heavier than water it settles down and this minimises the chances of its vapourisation.
- ◆ Put the used syringe back in the kit, upside down.

Slides 17-19 give additional information about the seriousness of a mercury spill.

## Slide 21: Glutaraldehyde safety action plan

Implementing the nine-step programme, detailed in the slide, will eliminate all glutaraldehyde overexposure during routine work procedures.

- ◆ Identify usage locations: all departments that use glutaraldehyde must be identified. As many usage locations as possible should be eliminated. Usage should be centralised, where possible.
- ◆ Monitor exposure levels: measurement of glutaraldehyde exposure levels must be conducted in all usage locations using monitoring badges or hand-held direct reading meters.
- ◆ Training: an in-depth education and training programme should be conducted for all employees who work with hazardous chemicals.
- ◆ Use personal protective equipment: all employees who work with glutaraldehyde must be

provided appropriate protective equipment. This equipment includes proper eye/face protection, chemical protective gloves, and protective clothing. Only splash goggles with side shield protection and fitting snugly all around the eyes are acceptable when working with glutaraldehyde. These goggles should have combination eyeshield/face masks, which are commonly used for splash protection because the liquid could splash on the forehead and drip into the eyes. In addition to splash goggles, OSHA guidelines require face protection when working with glutaraldehyde. Employees should wear face shields that wrap around the face and extend down past the chin for adequate face protection.

- ◆ Administrative controls: Limit employee access to glutaraldehyde usage locations and eliminate as many usage locations as possible by centralising usage in a few locations. Central supply is a logical choice for such consolidation. Suitable eyewash units must be available for immediate emergency use in all glutaraldehyde usage locations.
- ◆ Work practice controls: Studies have shown that glutaraldehyde vapours increase whenever the solution is agitated. Vapour levels increase when glutaraldehyde is poured into or dumped out of a soaking bin, when instruments are placed into and removed from the solution, and when instruments are rinsed. Employees should be trained to minimise agitation of the solution as much as possible during these work procedures. If exposure monitoring shows that these procedures result in excessive exposure levels, the work process should be enclosed in a glutaraldehyde fume hood system.
- ◆ Engineering controls: Rooms in which glutaraldehyde is used should have a minimum of 10 air exchange rates per hour. General room ventilation, however, will not effectively control glutaraldehyde exposure levels. As

recommended, glutaraldehyde exposure limits decrease, installing glutaraldehyde local exhaust fume hoods becomes more important. Placing the glutaraldehyde-soaking bin in a fume hood will eliminate virtually all glutaraldehyde exposure problems. To ensure proper performance, the fume hood should have a minimum face velocity of at least 80 feet per minute.

- ◆ Neutralise solutions before disposal: Most healthcare facilities dispose of spent glutaraldehyde solutions by simply pouring them down a drain connected to a sanitary sewer. This practice may adversely affect the operation of the local sewage treatment facility. Pouring several gallons of glutaraldehyde solution may also cause significant worker exposure to glutaraldehyde vapours. These problems can be avoided by neutralising the spent Cidex. A neutralising agent will, over time, chemically inactivate the glutaraldehyde. Neutralisers such as dibasic ammonium phosphate solution, sodium bisulphate and liquid ammonium hydroxide can also be used.
- ◆ Develop a spill clean-up plan: A 'response team' should be created to develop and execute procedures for glutaraldehyde spills. All spills, no matter how small, should be cleaned up immediately.

#### Emergency measures for contacts and spills

- ◆ Accidental skin contacts must be dealt with immediately: wash under running water and dry thoroughly.
- ◆ Eye contact: report to the Acute Care Centre for eyes to be flushed with 1 litre of normal saline. Eyes can then be checked by the local medical officer.

◆ Minor spills are those small enough to be wiped with disposable cloths. These cloths must then be discarded in a *sealed* plastic bag, as general waste.

◆ Large spills for areas without floor drainage: Glutaraldehyde spill kits should be available. Wear full protective clothing and respirator. Use rolled towels around the edges of the spilled liquid to contain the spread. Neutralise the spill with appropriate neutralisers.

◆ Wipe with towels or mop up. Rinse towels or mops thoroughly under running water. Place the towels in a plastic bag and convey them to the laundry with a clear warning of their contents. Remove protective clothing. Decontaminate protective clothing and respirator.

#### Slides 22-25: Cytotoxic waste

Rules, 2016 have mentioned disposal and treatment technology for cytotoxic drugs. All cytotoxic drugs and vials (glass and plastic) contaminated with cytotoxic drugs should be disposed in a yellow bag and should be incinerated at a temperature  $> 1200^{\circ}\text{C}$  at Common Bio Waste Treatment Facility or a hazardous waste treatment facility.

#### Slide 26: Contaminated laundry

This slide enlists the standards given for contaminated laundry in the OSHA Blood-borne pathogen standards.

In most Indian hospitals, soiled linen generated in places like labour rooms, OTs or ICUs are disinfected at source by dipping in a 10 per cent bleaching solution, before giving it to the laundry department. This minimises the risk of infection during transportation and sorting. If the laundry is sent outside the hospital for cleaning, the hospital has to take extra precautions.

## **Slide 27: Follow up meeting with trainees**

### **Discussing problems, answering queries**

During the initial stages of implementation of a waste management policy, the staff is likely to have many questions. Teething problems should be resolved swiftly so that the staff does not lose confidence in the waste management process.

As problems emerge, one can make a list of them and discuss their solutions with staff members who might not have experienced those problems yet. Monitoring sheets are an excellent tool for uncovering problem areas of the waste management process. Senior people from the waste management committee, or any officer who has been instrumental in monitoring the waste management system, should maintain monitoring sheets that list various problems noticed in the system.

### **Awareness**

Posters, circulars and hospital magazines can be used to disseminate timely information on medical waste and its treatment. Posters can serve as a continuous reminder of existing waste management schemes. They would also help sensitise new staff and visitors to the hospital.

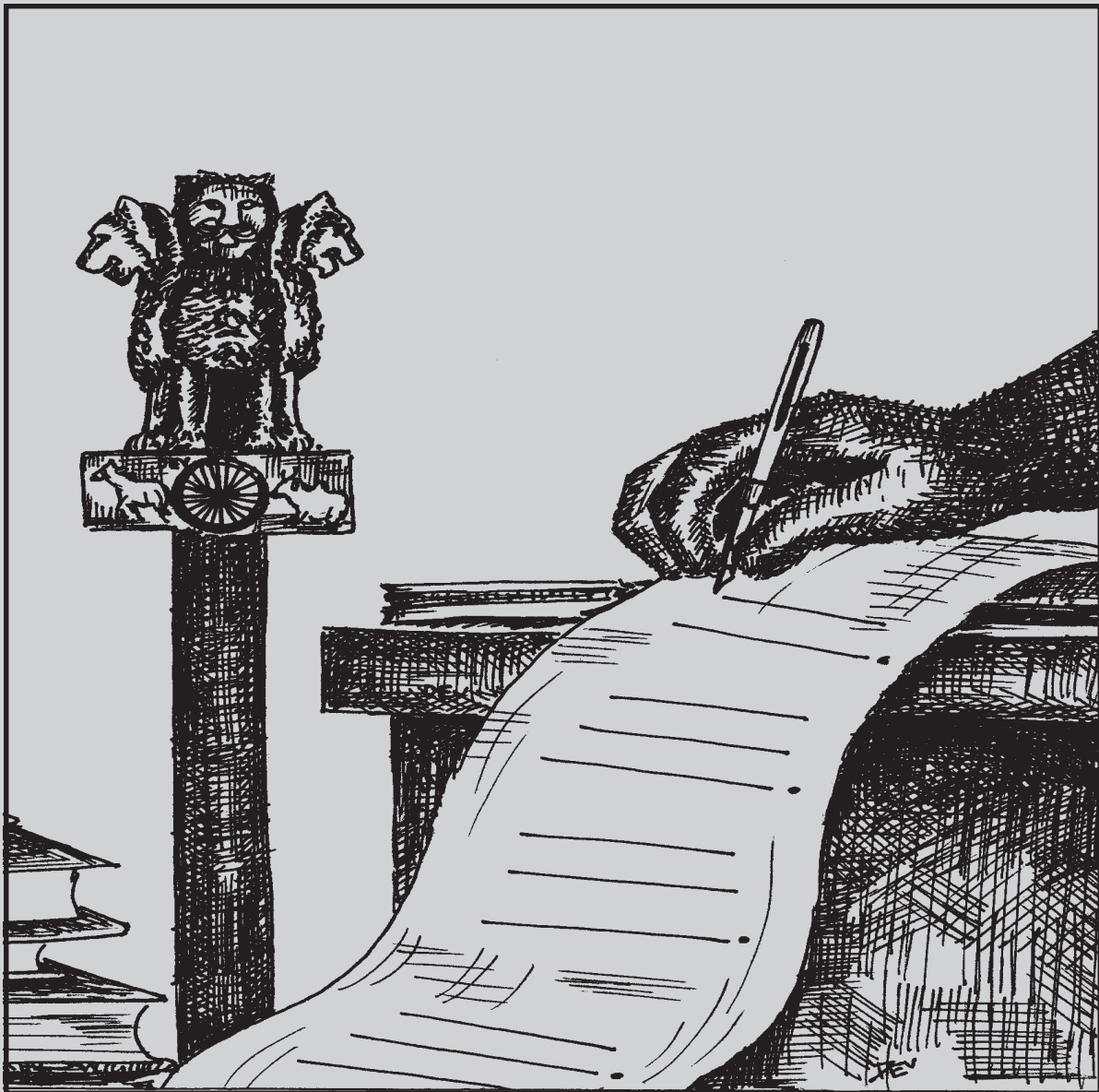
Staff meetings are also a good forum to raise awareness and discuss issues pertaining to waste management.

Various incentives and disincentives can be introduced to encourage people to follow the correct waste management techniques.



# *Section G*

## **Rules and policies**



# 61 Rules and policies

## **Bio-medical Waste (Management & Handling) Rules 1998**

Medical waste was earlier considered a part of municipal waste. It was only when the problems with mixing the two were realised that separate policies were framed for their treatment. In India, there was no legislation on medical waste till the Ministry of Environment and Forests came up with the first draft rules in 1995.

The rules recommended on-site incinerators for all hospitals with 30 or more beds. In the public interest case of Dr B.L. Wadhwa vs. Union of India, the Supreme Court of India, in March 1996, ordered that this rule be implemented in the city of Delhi. Srishti intervened with a Public Interest Litigation (PIL) of its own in which it petitioned for a review of this dangerous order. The court was also requested to include alternative technologies and their standards into the rules, both of which were agreed to.

The second draft rules were notified in 1997 and objections were invited from the public within 60 days from its date of publication on October 16, 1997. The final rules were notified on July 20, 1998 and were called Bio-medical Waste (Management & Handling) Rules, 1998.

Since then, three amendments have been made to the rules. The first amendment was notified on March 6, 2000 and is referred to as the Bio-medical Waste (Management & Handling) (Amendment) Rules, 2000. The amendment

extended the deadline for implementation of the rules, considering that when the first deadline for eight cities with a population of more than three million was over, these cities had not been able to achieve anything significant.

The second amendment to the rules was notified on June 2, 2000 and was called Bio-medical Waste (Management & Handling) (Amendment) Rules, 2000. Some of the major changes made through this amendment included defining the role of the municipal body, nominating Pollution Control Boards/Committees as prescribed authorities, addition of forms for seeking authorisation to operate a facility and for filing an appeal against orders passed by the prescribed authority.

The third amendment was notified in September 2003. It made DGAFMS (Director General Armed Forces Medical Services) the prescribed authority for medical waste management in all medical establishments under the Ministry of Defence.

## **Bio-Medical Waste Management Rules, 2016**

The new rules were notified in March, 2016 superseding the 1998 rules. The rules brought in a number of changes in management and disposal of Bio-Medical Waste.

<http://toxicslink.org/docs/Bio-Medical-Waste-Management-Rules-2016.pdf>

## **Slide 4: Provisions and clauses**

Schedule I categorises bio-medical waste into four categories and enumerates treatment and disposal options for each of them. Healthcare institutes are free to select the option best suited to them.

Where autoclave and microwave have been suggested as treatment options, advanced autoclaves (for example, a hydroclave) can also be used. Hydroclave was approved by the CPCB 'Peer and Core Group' after the final rules were notified.

The second amendment added the words 'Disposal options +', implying that the mentioned options are based on available technologies, and anyone interested in using other state-of-the-art technology would have to approach the CPCB for their approval.

Schedule II provides the standards for treatment and disposal of bio-medical waste, including standards for technologies, liquid waste and deep burial. The segregated waste has to be provided to CBWTF including pre treated laboratory and highly infectious Bio Medical waste. No hospital or health care facility is allowed to install on-site treatment and disposal facility, if a CBWTF is available within 75km. This has been reduced from 150 km as mentioned in 1998 rules.

The colour codes have been carefully chosen to distinguish waste as per its treatment option. They should be followed religiously. Segregation in colour-coded, labelled containers has been suggested for ease and uniformity.

Earlier black coloured bags were being used for 5,9 and 10 categories. However, in the new rules, 2016 only 4 coloured bags viz. Red, Blue, Yellow and White are assigned for all 4 categories of waste.

As general waste in any hospital is not subject to the provisions of the Bio-medical Waste Rules, Solid Waste Rules, 2016 should be applied to such waste.

Colours mentioned for general waste are: green for bio-degradable, white for recyclable and black

for any other kind of waste. Most of the waste generated in wards is either recyclable or bio-degradable, thus white or green bags can be used for general waste.

## Slide 5: Provisions and clauses

Containers of bio-medical waste should have appropriate labels (such as bio-hazard, cytotoxic, etc). The bags are required to be bar coded before sending it off for treatment. The vehicle of the treatment facility should have Global Positioning System installed for tracking the waste.

Bags should be sealed when they are three-fourth full and kept for collection and transportation to the designated site by the designated person. Transportation within the hospital should be carried out in trolleys, which should be designed in such a way that there is no spillage during transportation. Transport routes should preferably avoid patient areas and different time slots should be allocated for the transport of different wastes to reduce the chances of their mixing. Dedicated wheeled trolleys with labels and without any sharp edges should be available for this purpose. Regular cleaning and disinfection should be carried out along the transportation route. The waste generator is required to provide trainings to all healthcare workers at the time of induction and further once a year, the report of which should be submitted with the annual report.

To monitor the activities related to Bio medical waste management, a committee should be formed and for healthcare facilities having less than 30 beds, one person should be designated for the same.

## Slide 7: Authorisation

Any occupier or operator handling Bio Medical Waste is required to seek authorization. The prescribed authority viz. State Pollution Control Board and Pollution Control Committee will grant the authorization. The validity of this authorization (for bedded health care facility) will be

→ 2. LK Koolwal v. State of Rajasthan, AIR 1988.

synchronised with the validity of the consents. However, for non bedded occupiers the authorization will be required only one time.

Any healthcare facility can install bio medical treatment equipments in case a CBWTF is not available within 75kms, only after taking authorisation from the prescribed authority.

Centralised facility: anyone interested in setting up facilities for the collection, reception, treatment, storage, transportation and disposal of bio-medical waste shall also need to seek authorisation from the Prescribed Authority. Few terms and conditions have been listed in the rules and there is provision of any additional conditions that may be stipulated by the Prescribed Authority. Some significant points are listed below:

- ◆ The person authorised shall not rent, lend, sell, transfer or otherwise transport the bio-medical waste without obtaining prior permission of the Prescribed Authority.
- ◆ It would be the duty of the authorised person to take prior permission of the Prescribed Authority to close down the facility.

One instance of a specific condition being listed down by the Prescribed Authority to ensure smooth functioning of the system is seen in Andhra Pradesh. Here, in case of more than one facility being available, the facilities have to commit to act as a stand-by for each other in case of any problems. The treatment facility is required to inform the prescribed authority about the occupiers who are not handing over segregated waste.

Also, the treatment facility should impart training to its workers, once at the time of induction and then once a year. The treatment facility shall allow the occupier to visit the facility to check the treatment of the waste.

## Slide 8: Records

The concerned institution should maintain every detail pertaining to waste generation and its disposal. All records (including collection reports, immunisation, training, occupational safety, monitoring reports as well as operational records of Incinerator, autoclave etc.) upto 5 years are supposed to be updated on the waste generator as well as the treatment facility's website. This is to be compiled and submitted to the Prescribed Authority by 30<sup>th</sup> June every year. The records are also helpful during the internal audit of the waste procedures.

The type and quantity of waste generated, mode of transportation, people involved, level of segregation in each unit of the hospital, mode of treatment and the parameters of functioning of the treatment technologies or other relevant details of the procedure could be covered by the monitoring authority. Healthcare facilities as well as the treatment facilities are required to report all major accidents occurring during handling of Bio-Medical Waste and this has to be submitted to the prescribed authority along with the annual report.

Accident reporting formats should be made available at each hospital, either at a central place or at each work station. The rules mention that each accident involving waste should be reported, including accidents by fire hazards and blasts during handling of BMW. In case of a major accident, a report has to be sent within 24 hours.

CBWTF also has to make a record of recyclable waste which is sold to the recycler; this has to be submitted along with the annual report.

In the context of medical waste, an accident can include the following:

- ◆ Spillage of bio-medical waste during transportation within or outside the hospital.
- ◆ Spillage of blood or any other body fluid.



- ◆ Spillage/accidental exposure to any hazardous chemical or drug.
- ◆ Needle- stick injury to any personnel.
- ◆ Fire hazards or blasts during handling of BMW

## Slide 9: Categories

Schedule I of the rules categorises bio- medical waste into 4 categories according to the colour coding unlike 10 categories in the previous rule. Various treatment technologies have been suggested for each category and a particular option can be chosen depending on its availability and suitability.

Different areas within a hospital would be generating different types of waste. The number and type of bins can be decided, based on the type of waste generated at each location. 1. The four categories are:

- ◆ **Yellow:** All the human & animal anatomical waste; soiled waste; expired or discarded pharmaceuticals; chemical waste (including liquid waste); Blood or body fluid contaminated linen, mattresses or beddings; Microbiological, biotechnological and laboratory waste.
- ◆ **Red:** Contaminated recyclable waste containing tubings, bottles, catheters, urine bags, syringes (without needles and their vaccutainers) and gloves.
- ◆ **White (Translucent puncture proof bags):** Sharps containing waste including needles, scalpels, blades etc.
- ◆ **Blue:** All the broken or discarded glass including medicinal vials except for those contaminated with Cytotoxic drugs and the metallic body implants.

Rules, 2016 mentions usage of non chlorinated plastic bags and provides 2 year time to all the waste generators for the phase out of chlorinated plastic bags.

Rules, 2016 requires all the cytotoxic drugs whether expired, discarded any item including glass or plastic container contaminated with Cytotoxic drug to be discarded in the yellow container for incineration.

**Note:** Rules, 2016 also made a provision that all the mercury and lead waste being generated in the healthcare facility has to be managed and disposed according to its respective rules and regulations.

Some conditions that have been prescribed for various categories are:

- ◆ Deep burial is an option given for Anatomical and Soiled waste of the Yellow category Rules and policies but this can only be done in rural and remote areas where there is no access to CBWTF (Common Bio-Medical Treatment Facility) .
- ◆ Anything going for incineration should not be pre-treated with any chemical. Chlorinated plastic should not be incinerated.
- ◆ Any plastic bag used for collection of Bio medical waste should be non-chlorinated.
- ◆ The Red category waste containing plastics should be autoclaved/microwaved/hydroclaved followed by shredding or mutilation and should only be sent to an authorized or registered recycler and should never be sent to a landfill site.
- ◆ The occupier is required to pre treat the laboratory waste, microbiological waste, blood samples and blood bags by disinfection or sterilization before sending it to the treatment facility.
- ◆ Mutilation of mentioned waste categories is a must to prevent its unauthorised reuse. It has been mentioned, implying that one has to necessarily ensure mutilation, even if complete shredding cannot take place at a particular location.

### Slide 13: Take note

- ◆ The law prescribes a maximum time limit of 48 hours for storing waste. One must, however, make provisions for treating the waste on the same day. If, for some reason, untreated waste has to be stored beyond 48 hours, the Prescribed Authority needs to be informed about it. In Indian conditions with a hot and humid climate one has to be careful about storing the waste for so long.
- ◆ Chlorinated plastics are not to be incinerated. No chemical pre-treatment of waste is allowed before incineration. Chlorine content in the waste has been linked with the production of toxic gases like dioxins and furans, thus our rules prohibit the incineration of any chlorinated plastics. Since, in India, there is no provision of labelling of plastics it would be advisable to abstain from incinerating any plastic material. Most hospitals use chlorine-based disinfectants, thus it is essential that none of the waste destined for an incinerator is chemically pre-treated. This practice would help eliminate any chances of introduction of chlorine into the incinerator.
- ◆ Bags for collecting any category of Bio-Medical waste should not be made of chlorinated plastic. This provision is to avoid introduction of chlorine into the waste stream. Rules, 1998 emphasised that Non-chlorinated bags should be used for incinerable waste but as the new rules aim at phasing out of chlorinated plastics, thus, none of the bags should be chlorinated. These bags are readily available in the market and can be made up of polyethylene, polypropylene or any other non-chlorinated plastic.
- ◆ The label shall be non-washable and visible prominently. It should have details such as the date, category, class and description of waste. If transported off-site, the contact details of the sender and receiver should also be mentioned on the label. The labels help in tracking the waste to its origin in case of any problems or if

clarifications are required. They also help guide people handling the bags and act as warning signals for unauthorised people who may come in contact with the bags due to negligence or an accident. In case of off-site treatment the vehicle and driver should have visible notes/labels with all instructions. This is necessary, as in the event of an emergency information like precautions, immediate steps to be taken, contact number and names of people to be informed are available. The new rules also require bar coding of the bags so as to avoid any pilferage.

- ◆ Deep burial is an option given for Anatomical and Soiled waste of the Yellow category Rules and policies but this can only be done in rural and remote areas where there is no access to CBWTF (Common Bio-Medical Treatment Facility).
- ◆ For use of treatment options not specified in the rules, one shall approach Ministry of Environment, Forest and Climate Change (MOEF & CC).

### Slide 14: Role of municipal body

Schedule 2 of the Municipal Waste Rules, 2000, mentions that bio-medical waste shall not be mixed with municipal waste.

The Bio-medical Waste Rules specify that general waste and treated medical waste from the hospitals has to be treated as municipal waste and continue to be picked up by the municipal authorities.

### Slide 15: Role of Prescribed Authorities

The 2016 final rules, in its schedule III list the prescribed authorities and their corresponding duties.

MOEF & CC is the prescribed authority to make policies concerning Bio medical waste and is responsible to provide financial assistance for

setting up or up gradation of CBWTF. It is also responsible for reviewing the implementation of the rules once a year through SPCBs and CPCB.

The department in the business allocation of land assignment shall be responsible for providing suitable site for setting up of CBWTF in the State Government and Union territory Administration.

## Slide 16: Incinerator standards

The combustion efficiency is computed as:

$$\text{C.E.} = \% \text{CO}_2 / (\% \text{CO}_2 + \% \text{CO}) \times 100$$

The gas residence time in the secondary chamber is now increased to two seconds from 1 second.

Also the new rules have included more stringent emission standards for incinerators including standards for Mercury as well as Dioxins and Furans.

## Slide 18, 19: Environment Protection Act

Section 5: subject to the provision of this Act, the Central Government may issue directions in writing to any person. This includes the power to direct:

- a) The closure, prohibition or regulation of any industry, operation or process; or
- b) Stoppage or regulation of the supply of electricity or water or any other service.

Section 6: This section empowers the Central Government to make rules in respect of all or any environmental issues.

Section 8: no person shall handle, or cause to be handled, any hazardous substance except in accordance with such procedure and after complying with such safeguards as may be prescribed. Under the Act, a hazardous substance is defined as any substance or preparation which, by

reason of its properties or handling, is liable to cause harm to human beings, other living creatures, plants, micro-organisms, property or the environment.

*With reference to medical waste, mercury, glutaraldehyde, blood or body fluids will all fall under the hazardous waste category. Thus, all hospitals should have procedural safeguards to handle them.*

Section 10 (Power of entry or inspection): any person empowered by the Central Government (*Pollution Control Board under Bio-medical Rules*) shall have the right to enter, at all reasonable times with such assistance as he considers necessary, any place for inspection to ensure whether or not the rules are being complied with, inspecting records and equipment used to handle bio-medical waste, etc.

A hospital would be bound to render all assistance to the visiting member without delaying or obstructing him; an institution that fails to do this shall be guilty of an offence under this Act.

Section 11 (Power to take samples and procedures to be followed therewith): the Inspecting Officer would have the liberty to take samples (in the presence of the occupier) of any kind for analysis, after completely informing the occupier about the process, and issuing a notice then and there of his intention to get a sample analysed.

The samples have to be sealed and signed by both parties. In case the occupier wilfully absents himself during this process or refuses to sign, then the officer has the power to take the sample and sign it himself. The samples should then be sent for analysis to a government-approved laboratory without any delays.

Section 15 (Penalty for contravention of the provisions of the Act and the Rules, Orders and Directions): whoever fails to comply with or contravenes any provision of this Act, or the rules or orders or directions issued thereunder, shall, in respect of each such failure or contravention, be

punishable with imprisonment for a term which may extend to five years or with a fine which may extend to Rs 1,00,000, or with both. In case the failure or contravention continues, there would be an additional fine which may extend to Rs 5,000 for every day during which such failure or contravention continues after the conviction for the first such failure or contravention.

If the failure or contravention continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term, which may extend to seven years.

Section 16 (Offences by Companies): where an offence has been committed by a company, every person who, at the time the offence was committed, was directly in charge of, and was responsible to, the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against.

If the person proves that the offence was committed without his knowledge or that he exercised due diligence to prevent the commission of such offence then the person shall not be liable to be punished.

In case the offence is attributable to any other people in the company other than or in addition to the occupier, then that person would also be liable for punishment.

Section 17 (Offences by Government Departments): in case the government departments are involved, the head of the department (HOD) would be guilty. But, like the above clause, if the HOD proves that the offence was committed without his knowledge or he exercised due diligence to prevent it, he will not be guilty.

## **Slide 20: Other rules**

A hospital is basically a complex system and would generate various kinds of waste, including bio-medical, general, radioactive and hazardous waste. As there are already some guidelines/rules available for each of these aspects, these have not

been covered under Bio-medical Waste Rules. Hospitals are supposed to implement all relevant guidelines, applicable to them.

To assist implementers and enforcers of the Bio-medical Waste Rules, the government has come out with various guidelines, including the National Guidelines for Bio-medical Waste, Guidelines for Design and Construction of Incinerators and Guidelines for Common Bio-medical Waste Treatment Facilities.

# *Section H*

## **Treatment technologies and Common Bio-medical Waste Treatment Facility**



# H1 Treatment technologies and Common Bio-medical Waste Treatment Facility

## Slide 2: Introduction

A common bio-medical waste treatment facility (CBWTF) is a set up where biomedical waste, generated from a number of healthcare units, is treated centrally. This reduces the adverse effects of bio-medical waste as it is located far from the residential area.

Setting up a technology for waste management is an important decision which needs to be taken after the hospital has done audits and surveys to determine the type and quantum of waste generated by it. A hospital would have to decide on the technology which would be best suited for most of its waste and the capacity would have to be estimated by taking into account the present needs and the future growth estimates.

As more and more hospitals move towards centralized treatment facilities, it is important that city-wise quantifications of waste are also done. Before a centralized facility comes up, all healthcare facilities expected to use it should be asked to submit the type and amount of waste generated by them. This would help in determining the capacity and the type of technology needed. Most centralized facilities in India are now using a technology mix of 90 per cent non-burn and 10 per cent burn technology (there are continuing efforts on finding non-burn solutions for even this 10 per cent waste component). Some technologies have a minimum feed-rate in order to be cost-effective and a maximum design feed rate. The

range of waste generation during the expected life of the equipment should fall within this range.

## Slide 3: Draft Guidelines for CBWTF

Draft Guidelines on Common Bio-medical Waste Treatment Facilities have come through and some salient features have been discussed in this slide. These guidelines are laid by Central Pollution control board which explains how to run a CBWTF.

<http://toxicslink.org/?q=content/rules-regulations-and-guidelines>

There are other directives regarding the functioning of CBWTFs as per the new Bio-medical waste management Rules, 2016. According to them:

1. Hospitals cannot do on site treatment of bio-medical waste if a CBWTF is available at a distance of seventy-five kilometer.
2. Every CBWTF must have treatment equipments like incinerator, autoclave or microwave, shredder and effluent treatment plant as a part of treatment, prior to commencement of its operation.
3. Operator of a CBWTF should maintain a record of recyclable wastes which are auctioned or sold and the same shall be submitted to the prescribed authority as part of its annual report. The record shall be open for inspection by the prescribed authorities.

4. Bar code and global positioning system should be used by CBWTF which help in tracking the waste carried from healthcare facilities by their vehicles. This will help in monitoring whether the collected amount is reaching their facility without any pilferage on the way.
5. All the CBWTF vehicles should be labeled as given in part 'A' of the Schedule IV of the Bio-medical waste management Rules

#### **Slide 4: Technologies used in a CBWTF**

Different technologies which must be a part of a CBWTF along with the standards for their operation are mentioned below:

#### **Autoclave**

Autoclave is a low heat thermal process and it uses steam for disinfection of waste. The boiling point of water (reaches saturation) is dependent on its pressure; if the pressure is increased water boils at a higher temperature. Steam-based sterilization technologies make use of this principle.

An autoclave has an inner chamber where waste is loaded and surrounded with a jacket. Steam is applied to the inner chamber and the outside jacket. Heating the outside jacket reduces condensation in the inner chamber walls and allows the use of steam at lower temperatures.

The rules allow for use of different temperature, pressure and time combinations for a treatment cycle.

#### **Slide 5: Types of Autoclaves**

Steam is the disinfecting agent in autoclaves, thus it is very important that the entire waste comes in contact with the steam. Air, being an insulator, needs to be removed to ensure penetration of heat into the waste. Autoclaves are of two types

depending on the method they use for removal of air pockets.

Two common ways of doing this are:

- ◆ Gravity/downward displacement: these autoclaves take advantage of the fact that steam is lighter than air; steam is introduced under pressure into the chamber forcing the air downward into an outlet port or drain line in the lower part of the chamber.
- ◆ Pre/high vacuum: vacuum pumps are used to generate vacuum. This is therefore a more effective system to evacuate air pockets from the inner chamber, resulting in shortened sterilisation times. After the complete removal of air, steam is injected into the chamber.

#### **Slide 6: Stages in Autoclave Operation:**

Pre-heating: introduction of steam in the outer jacket.

- ◆ Loading of waste with an indicator.
- ◆ Air evacuation: air is removed using either the gravity displacement or the vacuum method.
- ◆ Steam treatment: steam is introduced into the chamber till the required temperature is reached. Additional steam is automatically fed into the chamber to maintain the temperature for a fixed time period.
- ◆ Steam discharge: steam is vented from the chamber, usually through a condenser, to reduce the pressure and temperature. In some cases a post-vacuum cycle is used to remove residual steam.
- ◆ Unloading: unloading is usually done after giving the treated waste some time to cool.
- ◆ Mechanical treatment: shredder/compactors/



grinders are attached to reduce the bulk of treated waste and to render it unusable.

## Slide 8: Types of waste allowed/disallowed

1. Yellow Category waste: Under this, soiled waste: items contaminated with blood and body fluids, including cotton dressings, soiled plaster casts, linen, beddings, etc.

2. Red Category – Contaminated Waste (Recyclables) - waste generated from disposable items other than the waste sharps, such as tubings, catheters, intravenous sets, syringes (without needles or fixed needles syringes), vaccutainers with their needles cut etc.

3. White Category (Translucent) - Waste sharps including metals: needles, syringes, scalpels, blades, glass etc. that may cause puncture and cuts. This includes both used and unused sharps.

4. Blue Category – Glassware – Broken or discarded & contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.

## Slide 9: Points to remember

- ◆ Segregation of waste is important to avoid emission problems.
- ◆ Proper ventilation should be ensured to reduce or eliminate odours and minimise exposure of workers to odours.
- ◆ Air evacuation is necessary to eliminate the possibility of air pockets which would decrease the efficacy of the system. Air evacuation is more effective in autoclaves with a pre-vacuum or multiple vacuum cycles. With higher vacuum levels and more cycles, the heat penetration is deeper and uniform. (All evacuated air, which may contain pathogens, must be disinfected

prior to being released into the environment. This is often done by mixing steam with the air or using a high efficiency particulate air (HEPA) filter which must be disinfected prior to disposal).

- ◆ Place bags in multi-load trays to increase surface area for disinfection.
- ◆ Facilities should do test runs to standardise the waste load, its type, composition, size and the cycle time and temperature using indicator strips. In case of bulky waste loads, or any other special type of waste, different options of cycle parameters can be used to ensure an acceptable level of disinfection. Indicator strips should be placed at the points of minimal contact; they can be placed at different places in a cycle to check for faulty points.
- ◆ Workers should be trained in all aspects of waste handling – from waste categorisation, handling, and accident reporting to personal protection.

## Slide 10 & 11: Microwaves- Action Mechanism

Microwaves can also be classified under steam-based low-heat technology, as disinfection happens through the action of moist heat and steam generated by microwave energy.

A magnetron is used to convert high voltage electrical energy to microwave energy, which is then transmitted into a metal channel called a wave guide that directs the energy into the treatment chamber.

The microwave cycles rapidly between positive and negative at very high frequency (around 2.45 billion times per second). This causes water and other molecules in the waste to vibrate swiftly as they try to align themselves to the rapidly changing electromagnetic field. The intense vibration creates friction, which in turn generates heat, turning water into steam.



The heat denatures proteins of the microbial cells, but in addition to this, denaturation may happen due to alignment of protein molecules in the field (even the protein molecules try aligning in the field and thus lose their complex structures and get denatured). Studies have shown that heat denaturation is a basic disinfectant and that without water the lethal effects of microwaves on dry microbial cells are reduced.

### **Slide 12: Advantages and Disadvantages**

The advantages of the microwave system is that there are minimal emissions, provided no hazardous waste is fed. Volatile and semi-volatile organic compounds, chemotherapeutic wastes, mercury and other hazardous chemical wastes and radiological waste should not be microwaved.

There are some disadvantages of using this system, including its high capital. As far as odour problems are concerned, they are minimised due to HEPA filters, but it is still a problem in the vicinity of the machine. There is probability of microwave energy leakage and thus workers should be trained on a regular basis to inspect, monitor and contain any leakages.

### **Slide 15: Hydroclave**

Hydroclave is steam treatment with fragmentation and drying of waste. It has a double walled chamber with an agitator inside it, Steam is injected into this wall (jacket) and waste is loaded in the inner chamber. The agitator fragments and turns waste. The moisture in the waste turns to steam and exerts pressure on the inner walls. If this pressure is not sufficient, additional steam may be injected inside. Finally the steam is vented through a condenser while maintaining heat input, causing the waste to dry now the steam is shut off, discharge door is opened and agitator runs in reverse rotation to place the waste on a conveyor belt/ container.

One hydroclave cycle runs at 132°C for 15 minutes or at 121°C for 30 minutes.

### **Slide 18: Plasma Pyrolysis or Gasification**

Plasma is a physical state of matter consisting of ionised particles. Ionised gas can conduct electric current but due to its high resistance, the electric energy is converted to heat producing temperatures from 3,000-21,000 oF. Most systems use a plasma arc torch to generate the plasma energy.

It is a process which converts organic matter into synthetic gas, electricity, and slag using plasma. A plasma torch powered by an electric arc, is used to ionize gas and catalyze organic matter into synthetic gas and solid waste (slag).

### **Action Mechanism**

A plasma torch itself typically uses an inert gas such as argon. The electrodes vary from copper or tungsten to hafnium or zirconium, along with various other alloys. A strong electric current under high voltage passes between the two electrodes as an electric arc. Pressurized inert gas is ionized passing through the plasma created by the arc. The torch's temperature ranges from 4,000 to 25,000 °F (2,200 to 13,900 °C). The temperature of the plasma reaction determines the structure of the plasma and forming gas. This can be optimized to minimize ballast contents, composed of the by products of oxidation: CO<sub>2</sub>, N<sub>2</sub>, H<sub>2</sub>O, etc.

The waste is heated, melted and finally vaporised. At these conditions molecular dissociation can occur by breaking down molecular bonds. Complex molecules are separated into individual atoms. The resulting elemental components are in a gaseous phase.

### **Slide 19: Dry Heat Sterilization**

High velocity heated air: this system, being used

in some countries, uses heated air at high speed. After the waste is loaded, it is shredded and then transferred to a treatment chamber. Hot air is directed in a way that causes the waste particles to rotate turbulently around a vertical axis in a torroidal mixing action. This causes high rates of heat exchange and within four to six minutes, dry unrecognisable waste is ejected.

The type of waste to be treated and emission problems with this system are similar to those of autoclaves.

This technology requires a temperature of 185°C for a residence time of 150 minutes, with a sterilization period of 90 minutes.

### **Slide 20: Incineration**

Incineration is a burn technology and high temperatures are used to kill the pathogens and, in the process, destroy the materials on which they reside. During incineration and post combustion cooling, waste components dissociate and recombine, forming hundreds and thousands of new molecules, which are referred to as products of incomplete combustion (PIC). Metals are not destroyed but are dispersed into the environment. Theoretically, an incinerator would change all hydrocarbons to carbon- dioxide and water, but this does not happen in practice.

“The complete combustion of all hydrocarbons to produce only water and carbon- dioxide is theoretical and could occur only under ideal conditions...real-world combustion systems however, virtually always produce PICs, some of which have been determined to be highly toxic.

The deviations from theoretical running are called ‘combustion upsets’. These upsets are classified as macro- and micro-level upsets.

- ◆ Macro-level upsets include equipment failure, human error and rapid changes in the waste fed to the machine.

- ◆ Micro-scale upsets include transient departures from ideal conditions and are usually a consequence of a rapid perturbation in the incineration operation resulting from a rapid transient in feed rate or composition, failure to adequately optimise a liquid fuel, excursions in operating temperatures, instances where the combustible mixture fraction is outside the range of good operating practice, or inadequate mixing between the combustibles and the oxidant.

### **Slide 21: Incineration Standards**

The combustion process should be done in two stages: primary and secondary.

#### **Primary Combustion**

A primary combustion chamber in an incinerator, ideally, performs the following functions:

- ◆ Evaporates the moisture content of waste in a short time, followed by rising temperature of the organic waste to decompose and devolatilise. The volatile matter ignites, giving a flame atmosphere to complete devolatilisation of organic matter.
- ◆ Temperature should be minimum 800 °C and not more than 850° C, whereby residual char becomes less reactive, and thus, makes complete combustion of carbon more difficult.

#### **Secondary Combustion**

The secondary combustion chamber is mainly meant for total combustion of volatile matter, gases and products of incomplete combustion generated in the primary chamber. This is done by presence of excess air, maintenance of temperature above 1,000° C and also mixing of the gases usually affected by change of direction in the flow path.

Residence time: volatile organics will require a residence time of two seconds at 1,050° C  $\pm$  50° C for 99.99 per cent combustion, for which

sufficient volume must be provided for gas phase transformation.

The new rules, 2016 have made incineration standards stringent with an introduction of standards for Dioxins, Furans, Mercury and its compounds.

## **Slide 22: Dioxins: Where does it come from?**

Dioxins have no commercial value; they are an unintentional by-product of waste combustion and some manufacturing processes.

Dioxins are a group of 75 chemicals, which co-occur with another group of toxins called furans (a group of 135 chemicals). Dioxins are poly-chlorinated dibenzo-para-dioxin (PCDDs) and furans are poly-chlorinated-dibenzo-furans (PCDFs). Seven congeners of the dioxin family and 10 of the furans family are very toxic. Amongst these, 2,3,7,8, tetra-chlorinated dibenzo-para-dioxin (2,3,7,8, TCDD) is the most toxic and, consequently, the most researched.

Dioxins are toxic even in doses too low to measure; in fact, there may not be any safe limit of exposure to them. The chlorine bonds of these molecules are very strong and are resistant to any physical or chemical breakdown. This makes the toxins persistent and they bio-accumulate through the food chain.

Due to its tendency of accumulation in fatty tissues, dioxin travels up the food chain. Exposure to humans can happen through consumption of dairy products, fish, meat etc. These sources are in turn exposed to dioxin settled in soil, water and plant surfaces. Dioxins get deposited in the adipose (fat) tissue of the body and bio-accumulate in the food chain. Thus a fish may have ten to thousand times higher dioxin concentrations than the surrounding water.

## **Slide 23: Medical waste incineration and dioxins**

Dioxins are produced when organic material is burned in the presence of chlorine. Other than medical waste incineration, other things have also been implicated in dioxin formation, like- some industrial processes, hazardous and Incineration and its hazards municipal waste incineration, metal smelting, vehicles running on leaded gasoline, processes of the paper and pulp industry, etc.

Medical waste incinerators, however, remain one of the largest dioxin producers; this is due to the high amount of poly-vinyl-chloride (PVC) used in the medical sector. PVC is a very rich source of chlorine. Metals present in the waste act as a catalyst to dioxin formation.

Initially, the incineration industry denied charges of dioxin formation on the grounds that as long as high temperatures are maintained in the incinerator, dioxins would get destroyed. Later, some groups showed that dioxin could be reformed after the flue gases left the combustion chamber. It is now well-established that if flue gases are passed through pollution control equipment working in the temperature range of 200-400°C, more than a hundred fold increase in dioxin and furan formation can take place. Moreover, if the pollution control equipment captures the pollutants in flue gases, it becomes rich in these toxins.

Minimising this formation would require immediate quenching of flue gases, once they leave the combustion chamber. As a continuous monitoring of dioxins cannot happen, it is very difficult to ascertain whether or not the incinerator is running safely; it is thus always risky to run it.<sup>1</sup>

## **Slide 24 & 25: Human Health effects of Dioxin**

Dioxins have been linked to some very serious health effects, including cancer. The 1994

USEPA draft assessment estimated that the levels of dioxin-like compounds found in the general population may cause a lifetime cancer risk between one in 10,000 to one in 1,000. This is 100 to 1,000 times higher than the risk level of one in million that is considered Incineration and its hazards acceptable in certain regulations.

Dioxins damage the immune system leading to increased susceptibility to infectious disease. Dioxins are also endocrine disrupting, which means that they mimic our body's hormones and thus activate or suppress receptors and their associated cascades at the wrong times. As the endocrine system works at very low hormone concentrations and works via an amplification cascade, dioxin is capable of acting at low levels and causing serious effects.

### **Dioxin levels in India**

India is yet to realize the gravity of dioxin contamination and its related health effects. The government has not conducted any study to find out the levels of dioxin exposure in the population. Two recent studies have found very high amounts of dioxins in samples of Indian breast milk (human), meat and dairy products. Until now considered a Western problem, this scary trend should make our environmental managers and industry sit up.

In the first study, dioxins were detected in human breast milk samples collected from Perungudi, Chennai, in August 2000. The town has dumping sites of municipal wastes in the suburbs. Dioxin levels of people living here were found to be higher when compared with those in the general public of developed countries, such as Japan, USA and Canada. This indicates that significant pollution sources of dioxin-related compounds are present in dumping sites in India, probably due to secondary formation caused by burning of municipal wastes.<sup>2</sup>

In the second study, concentrations of dioxins were measured in the tissues of humans, fish, chicken, lamb, goat, predatory birds and dolphins of the river Ganga. The tissue samples were collected from different locations in India.

Dioxins were found in most of the samples analysed, with the liver of the spotted owl containing the highest concentration of 3,300- pg/g fat weight, while in human fat tissues dioxin concentrations ranged from 170 to 1,300 pg/g fat weight. As compared to even conservative WHO limits of 1-4 pico grams per kg of body weight, the study translated to alarmingly high contamination levels. This is the first study of its kind that has detected dioxins in human tissues, fish, meat and wildlife samples collected from India.

Why are these studies so significant? Firstly, they are the first ones to be carried out in India, and among a few in developing countries. Secondly, India has been refusing to acknowledge that dioxin is a problem.

Introducing Dioxin standards for the incinerators is a step forward by India in reducing the formation of this toxic pollutant.

### **Slide 26: Ash**

Two kinds of ash are produced in an incinerator: bottom ash (around 90 per cent of the ash), which consists of large particles and falls through the grate system in the furnace, and fly ash, a fine material that is collected in the boilers, the heat exchangers and the pollution control equipment.

Bio-medical rules ask for regulation of incineration ash at common hazardous waste treatment and disposal facility. However, it may be disposed of in municipal landfill, if the toxic metals in incineration ash are within the regulatory quantities as defined under the Hazardous Waste (Management and Handling) Rules, 2008.

- 1. Municipal waste incineration: A poor solution for the twenty first century, Dr Connert P, 4th Annual International Management Conference Waste to Energy 1998, Healing the Harm, Healthcare without Harm
- 2. Dioxin paper presented at Dioxin, 2001, International Symposium on Halogenated Environmental Organic pollutants and POPs, Kyoung ju, Korea, September 2001

Ash needs to be checked prior to land filling for 40 toxins (which are likely to leak) using the TCLP test. USEPA has given the regulatory levels for maximum concentrations of contaminants in wastes for the TCLP test (Toxic Characteristics Leaching Procedure) and these have been adopted by India also. In the TCLP test, constituents are extracted from the waste and tested. If they equal or exceed the specified limits they need to be treated before landfilling. All this adds up to the incinerator's running cost. But such things are not being practiced anywhere in the country.



# *Section I*

## **Annexures**



## Annexure 1: Medical waste management in rural waste

→ 1. Personal communication with a hospital in Ghaziabad.

**A** small rural healthcare setup of around 20 beds generates approximately 2 kg of infectious waste in a day.<sup>1</sup> The waste generated, typically includes the following:

- ◆ Infectious waste: placentas, blood soaked cotton and bandages, body fluids.
- ◆ Infectious plastic waste: disposable syringes, IV sets and tubes.
- ◆ Sharps: metal sharps mainly needles and scalpels, glass sharps including broken glasses.
- ◆ Waste generated from immunisation practices: new widespread immunisation programmes are generating millions of single-use syringes globally. These programmes need to incorporate effective systems for safe handling, treatment, and disposal of these syringes.
- ◆ General waste: packaging material, paper and food waste.

### Legislation for rural areas

The Bio-Medical Waste (Management & Handling) Rules, 1998 make it mandatory for all healthcare establishments in rural areas to:

- ◆ Segregate waste at source.
- ◆ Secure collection and transportation.

- ◆ Incorporate deep burial of pathological tissues and animal waste (where the population is less than 5,00,000).

- ◆ Adopt chemical/steam disinfection methods for other bio-medical waste streams.

### Treatment options for infectious waste

Generally, infectious waste in rural areas is disposed of through open burning or dumping. However this practice should be totally discouraged as it poses a serious threat to the environment and community.

Small clinics or rural areas that generate small volumes of waste may use on-site waste burial pits, as per standards laid down in the Bio-Medical Waste (Management & Handling) Rules, 1998 in areas with population less than 5,00,000.

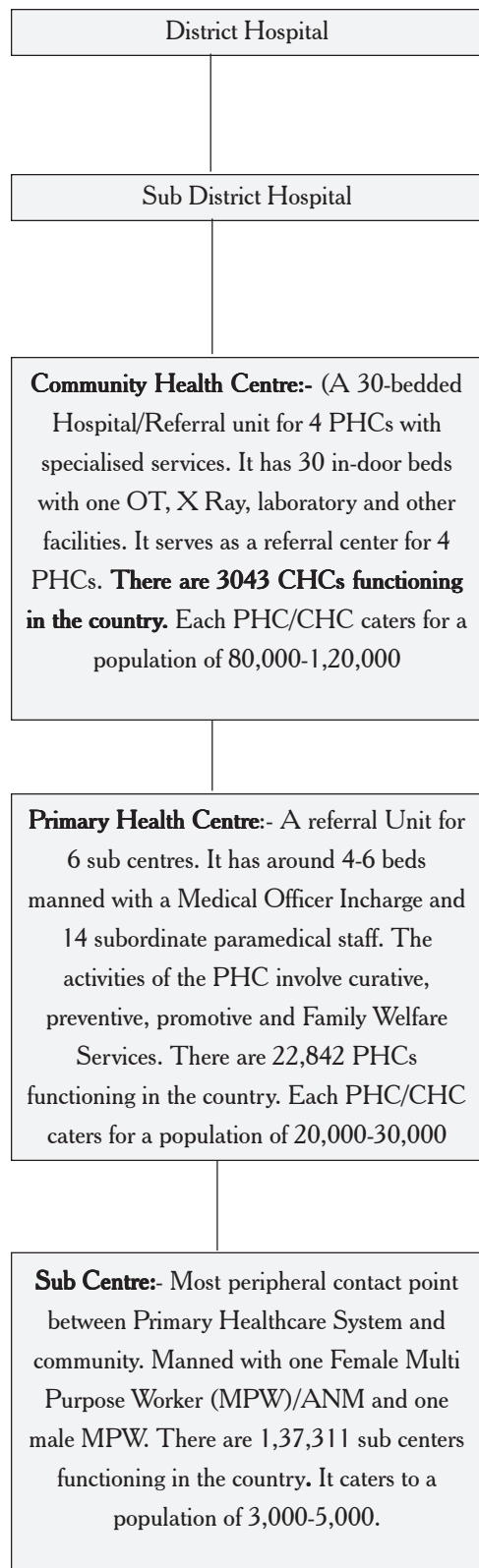
A pit or trench should be dug about 2 meters deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.

On each occasion, when waste is added to the pit, a layer of 10 cm soil shall be added to cover the waste. The deep burial site should be relatively impermeable and no shallow well should be close to the site.

### For infectious plastic waste



## The rural healthcare system in India



Autoclaves are a standard equipment in hospitals and have been used for many years by institutes to sterilise reusable medical instruments and glassware. They range in size from small portable units to huge units.

One advantage of the autoclave is that the equipment is simple enough to be manufactured locally with a light industrial manufacturing sector. It may also be possible to use other energy sources such as gas-fired, kerosene, electricity and locally available steam. The autoclaves should be tested under representative conditions to ensure microbial inactivation.

### For sharps

It is estimated that each year about 12 billion preventive and curative injections are administered worldwide, which amounts to almost 14 million injections per day.<sup>2</sup> Of these, 95 per cent are therapeutic in nature. For every vaccination given, 20 therapeutic injections are administered. Currently, 90 per cent of the syringes used are reusable in nature but the scare of spread of highly infectious diseases like hepatitis B and AIDS have seen the replacement of re-usable syringes with single use or auto disable syringes.<sup>3</sup>

The major challenges associated with the use of disposable syringes are the volume of waste that is generated and its management. The volume of sharps waste will grow exponentially, with estimates of 700 million auto-disable syringes being procured by 2005 for global immunisation programmes (as estimated by WHO). With around 85 per cent of the immunisations being provided in rural India (as estimated by PATH) the quantity of waste generated in rural areas is likely to grow rapidly.

### Current immunisation practices

The government will introduce Auto Disable

→ 2. Unsafe injections in the developing world and transmission of blood borne pathogens: a review, Simonsen L, Kane A, Lloyd J; Bulletin of WHO 1999, 77(10): 789-800.

→ 3. [injectionsafety.org/htmlwhoboard.html](http://injectionsafety.org/htmlwhoboard.html)

syringes for all immunisation programmes by 2005. This will generate 210 million syringes, of which, around 80 per cent would be in rural centres. The best method for disposing them would entail disinfection and mutilation near the source, and looking for recycling options. The following section deals with some simple ways of handling the sharps generated.

## Sharps pit

Blades and needles waste after disinfection should be disposed in a circular pit or rectangular pit as shown in figure below. Such 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, which is penetrated by a galvanised 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.<sup>4</sup>

## Encapsulation

Encapsulation is another way of safely disposing sharps. Sharps can be collected in puncture- and

leak-proof containers, such as high-density polythene boxes, metallic drums, or barrels. When the container is three-quarter full, a material such as cement mortar, or clay can be poured until the container is completely filled. After the medium has dried, the containers are sealed and disposed in landfills.

## Needle destroyers/cutters

Needle destroyer is an electrical gadget that mutilates the needle. The destroyer has an exposed filament. When the needle is inserted, the circuit inside gets completed and a high temperature electric arc is generated which burns the needle. The destroyer also has a cutter to cut the nozzle of the syringe so that it can no longer be used. Needle destroyers range from battery run portable devices to plug-in desktop units. Most are automated for one-hand quick operation to prevent needle-stick injuries.

## Centralised treatment technology

Rural communities can be served with a regional or district-level central facility utilising cleaner alternatives. A system of sharps collection, transport and centralised treatment can serve both urban and rural needs. In case of an immunisation campaign, the transport system could be arranged in conjunction with the delivery of vaccine supplies and safety boxes. The safety boxes or sharps containers can be brought back to a centralised facility or a PHC that uses an autoclave. In areas where technologies are not available, the centralised facility could use a combination of treatment with a disinfectant and cement encasing or encapsulation.

## Cost comparisons

- ◆ Sharps pit: Rs 10,000-Rs 20, 000 (concrete walls and rust proof lining)

→ 4. As per the Report of the committee constituted by The Ministry of Environment and Forests to formulate guidelines for implementation of Bio-Medical Waste (Management and Handling) 1998.

Figure 1. Infectious waste burial pit

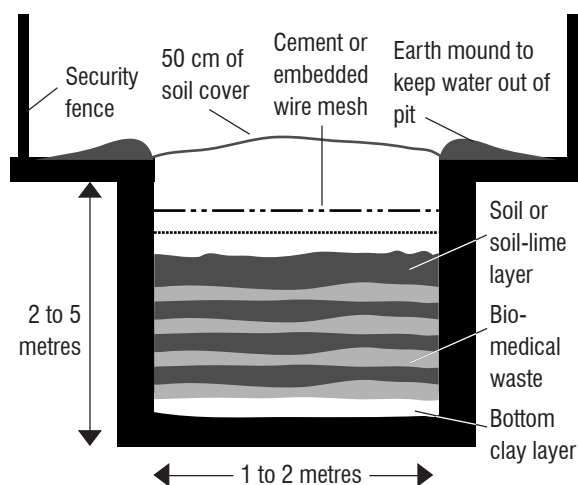
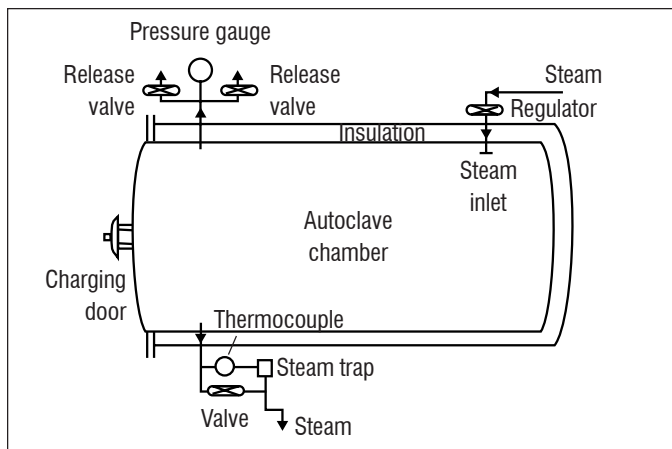
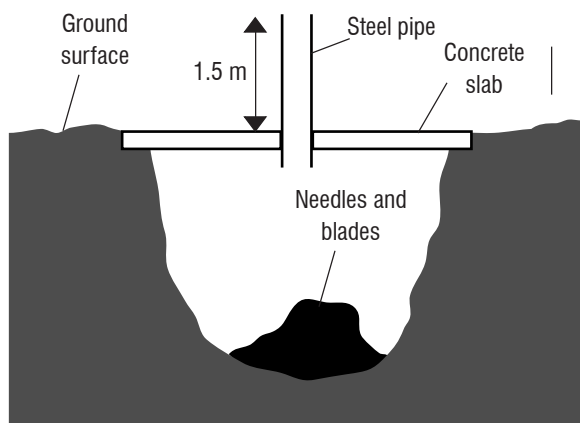


Figure 2: Autoclave



- ◆ Encapsulation: Rs 150-400 (depending on the size of the cement drums)
- ◆ Portable autoclaves (size 350mm diameter x 325 mm height): Rs 2,500-5,800 (depending in aluminum or steel body)
- ◆ Needle destroyer: Rs1,500-4,000
- ◆ Mechanical needle cutters: Rs 200-500

Figure 3. Pit for disposing of sharps



## Anexure 2: Sharps injuries

Table 1 (below) provides data on the type of exposure by profession. There were a total of 626 reported exposures as of January 1996. Nurses sustained the largest number of exposures (441, or 70 per cent) and needlestick injuries were the most common exposure type (378, or 60 per cent).

Table 2 shows the exposures that probably could

**Table 1: National surveillance of occupational exposure to HIV –exposure types by occupational group (as of January 1, 1996)**

	Nurse	Therapist/ technician	Student/ resident	Laboratory technician	Physician	Other	T o t a l
Needle-stick	281	15	20	26	20	16	378 (60%)
Surgical instrument wound	18	0	3	6	3	5	35(6%)
Mucous membrane	44	6	1	9	4	4	68(11%)
Skin contact: Intact	5	1	0	2	2	2	12(2%)
Non-intact*	59	5	1	4	4	4	76(14%)
Unknown	34	3	0	0	0	0	37(7%)
<b>Total</b>	<b>441(70%)</b>	<b>30(5%)</b>	<b>25(4%)</b>	<b>57(9%)</b>	<b>33 (5%)</b>	<b>40 (7%)</b>	<b>626 (100%)</b>
* skin with cuts, rashes, abrasions, lacerations, etc.							

have been prevented by adherence to the Universal Precautions (223/626 or 36 per cent). The skin contact exposures could have been prevented by covering open areas of the skin before beginning the procedure. Proper handling and disposal of used needles could have prevented 101 exposures.

**Table 2: National surveillance of occupational exposure to HIV –Preventable exposures to blood/body fluids (as of 1 January, 1996)**

Description of exposure	Number of workers	(%)
Recapping a used needle	57	25%
Improper disposal of a used needle	44	20%
Skin contact	122	55%
<b>Total</b>	<b>223</b>	<b>100%</b>

## Annexure 3: Glutaraldehyde safety products

Product Name and Manufacturer	Comments
<b>Controlled Work Stations</b>	
GUSÔ Glutaraldehyde User Stations Medical Products Corporation <a href="http://www.kemmed.com/">Http://www.kemmed.com/</a> ; 800-553-0330	Ductless enclosure units for glutaraldehyde trays/bins. Seven different models/sizes. Routine maintenance required
Chemdaq Corporation <a href="Http://www.chemdaq.com/glutaral.htm">Http://www.chemdaq.com/glutaral.htm</a> 800-245-3310	
<b>Aldehyde Neutralisers</b>	
GLUT-RxÔ Glutaraldehyde Solution Neutralizer, Kem Medical Products Corporation; <a href="http://www.kemmed.com/">http://www.kemmed.com/</a> 800-553-0330; 516-454-6565	Aldehyde neutralisation may be required by some publicly operated treatment works (POTWs) before dumping spent glutaraldehyde solutions down the drain. Neutralises waste glutaraldehyde solutions in thirty minutes or less.
ALDE-XÔAMS 1010, Aldehyde Management System ISOLYSERÔ <a href="http://www.sigma-aldrich.com">http://www.sigma-aldrich.com</a> 800-325-3010; 314-771-5765	Neutralises waste glutaraldehyde solutions.  Available in crystal form (for solid waste disposal) and liquid (for drain disposal) Liquid form requires 4 hours
GLUT-SAFE Neutralizer and Absorbent Mats, Health Choice Enterprises <a href="http://www.healthchoiceproducts.com">http://www.healthchoiceproducts.com</a> 800-957-4758	Neutralises waste glutaraldehyde solutions.
<b>Safety Equipment</b>	
GLUT-RxÔ Safety Nozzles and Absorbent Mats, Kem Medical Products Corporation <a href="http://www.kemmed.com/">http://www.kemmed.com/</a> 800-553-0330	Avoids spills, sloshes and gugging effects of pouring.
<b>Meters</b>	
Kem GLUTARALDEMETERO Kem Medical Products Corporation <a href="http://www.kemmed.com/">http://www.kemmed.com/</a> 800-553-0330; 516-454-6565	Measure actual glutaraldehyde levels Records instantaneous exposure assessment down to .05 ppm.
<b>Spill Response</b>	
Glutaraldehyde Spill Response Kit Health Choice Enterprises <a href="http://www.HealthChoiceProducts.com">http://www.HealthChoiceProducts.com</a> 800-957-4758	Neutralising solution to isolate and absorb spills and reduce vapour exposure to make clean-up safer.

## Annexure 4: What is HuMAN?

HuMAN is a national network of individuals and groups with a common goal of working for the evolution, development and implementation of safe practices in healthcare waste management.

### HuMAN's mission statement

The Health & Us Medical Action Network (HuMAN) seeks to make the delivery of healthcare in India safe – for the patient as well as for the environment, healthcare workers and the community at large. This it aims to do through adopting safe practices, products, procedures and technologies without compromising patient care.

### HuMAN's objectives

- ▲ To work towards the evolution and adoption of safe and standard practices in healthcare waste management including handling, treatment and disposal.
- ▲ To help eliminate the use of burning any waste, including incineration in all possible instances

to safer treatment methods.

- ▲ To reduce, with the aim of the elimination of the use of toxic chemicals (for example, mercury), non-essential plastics and potentially toxic materials (for example, PVC) in healthcare.
- ▲ To work for the occupational safety of healthcare workers.
- ▲ To protect community health and the environment.

### HuMAN Secretariat address

HuMAN, H-2 Jangpura Extension,  
New Delhi 110 014.  
Tel: 011-243320711, 24328006;  
Fax: 011-24321747

## **Annexure 5: American Nurses Association – working for a safer work place**

**T**he American Nurses Association (ANA) has been fighting the silent epidemic of needle- stick injuries since 1980s, through its Safe Needles Save Lives campaign. The association works at the grassroot and policy level. At the grassroot level, nurses are trained and educated about the risks of needlestick injuries, how to avoid such injuries and the action to be taken after any such incident. All this work is done through the state nursing associations.

ANA has also worked with members of Congress to draft the Healthcare Worker Needlestick Prevention Act, which was introduced in the US Senate and House in May 1999. Due to ANA's efforts, the Occupational Safety and Health Administration (OSHA) has added needlestick prevention to its agenda. The American Nurses Association's (ANA) 'Safe Needles Save Lives' campaign scored an important victory for ANA and its constituent members (the state nurses associations) when OSHA on November 5, 1999 published a long-awaited directive which will have a life-saving impact on nurses by effectively mandating the use of safer needlestick devices nationwide.

The Healthcare Worker Needlestick and Sharps Injury Prevention Act was finally passed due to associations' continuous efforts.



## Annexure 6: Related Web Sites

- ◆ USEPA: <http://www.epa.gov/ebtpages/wastmedicalwaste.html>
- ◆ California Department of Health Services: [www.dhs.cahwnet.gov/ps/ddwem/environmental/emb/medwasteindex.htm](http://www.dhs.cahwnet.gov/ps/ddwem/environmental/emb/medwasteindex.htm)
- ◆ Ecology centre: [www.ecocenter.org/healthwaste.shtml](http://www.ecocenter.org/healthwaste.shtml)
- ◆ Sustainable hospitals: [http://www.sustainablehospitals.org/HTMLSrc/IP\\_factsheet\\_contents.html](http://www.sustainablehospitals.org/HTMLSrc/IP_factsheet_contents.html)
- ◆ Healthcare Without Harm: [www.noharm.org](http://www.noharm.org)
- ◆ GAIA: <http://www.no-burn.org>
- ◆ Virginia Department of Environmental Quality: <http://www.deq.state.va.us/waste/medical.html>
- ◆ University of Berkeley: <http://www.ehs.berkeley.edu/default.html>
- ◆ WHO: [www.who.int/health\\_topics/medical\\_waste/en/](http://www.who.int/health_topics/medical_waste/en/)
- ◆ SIGN: [http://www.who.int/injection\\_safety/sign/en/](http://www.who.int/injection_safety/sign/en/)
- ◆ OSHA Blood-borne Pathogens: <http://www.osha.gov/SLTC/bloodbornepathogens/index.html>
- ◆ CDC (NIOSH): <http://www.cdc.gov/niosh/healthpg.html>
- ◆ American Nursing Association: <http://ana.org/needlestick/nshome.htm>
- ◆ Toxics Link: [www.toxicslink.org](http://www.toxicslink.org)
- ◆ Ban the Burn: <http://www.essentialaction.org/waste/index.html>
- ◆ Work on Waste: <http://www.workonwaste.org>
- ◆ Environmental Research Foundation: [http://www.rachel.org/home\\_eng.htm](http://www.rachel.org/home_eng.htm)

- ◆ Hospitals for a Healthy Environment: <http://www.h2e-online.org/>
- ◆ Bio-Medical Waste (Management and Handling) Amendment Rules 2000: <http://kspcb.kar.nic.in/BMW/Laws.htm>
- ◆ Nightingale Institute: <http://www.nihe.org>
- ◆ University of Virginia: <http://www.virginia.edu>

## Annexure 7: Publications

### Publications: Incineration

- ◆ *Non-Incineration Medical Waste Treatment Technologies*, a Resource for hospital administrators, facility managers, healthcare professionals, environmental advocates, and community members, August 2001
- ◆ *Medical Waste Treatment Technologies: Evaluating Non-incineration Alternatives* (pdf), a tool for healthcare staff and concerned community members, May 2000
- ◆ *How to Shut Down an Incinerator, a Toolkit for Activists*
- ◆ *What's Wrong with Incineration?* (pdf), Going Green Factsheet 3-2
- ◆ *Bankrolling Polluting Technology: The World Bank Group and Incineration*, Global Alliance for Incinerator Alternatives, September 2002
- ◆ *California Medical Association Resolution on Dioxin and Medical Waste Incineration*, CA Medical Association, March 12, 2000
- ◆ *When Healthcare Harms; The Dangers of Incinerating Medical Waste*, American Journal of Nursing, April, 2001 (Volume 101, Issue 4), Ann Melamed, RN, and Susan Wilburn, RN
- ◆ *Waste Incineration: A Dying Technology*, GAIA, 2002

### Publications: Waste minimisation

- ◆ *Waste Minimisation, Segregation and Recycling in Hospitals* (pdf), Going Green Factsheet 4-1
- ◆ *10 Ways to Reduce Regulated Medical Wastes* (pdf), Going Green Factsheet 4-2
- ◆ *Guidelines for Optimising Waste Segregation* (pdf), Going Green Factsheet 4-3
- ◆ *Disposables and their Alternatives* (pdf), Going Green Factsheet 4-4

- ◆ *Reach for Unbleached Paper* (pdf), Going Green Factsheet 4-5
- ◆ *Recycling Fact Sheet* (pdf), Going Green Factsheet 4-6
- ◆ *Waste Minimisation Resources* (pdf), Going Green Factsheet 4-7
- ◆ *Reprocessing Single-use Medical Devices White Paper* (pdf), proceedings from Setting Healthcare's Environmental Agenda, October 16, 2000
- ◆ *Waste Management White Paper* (pdf), proceedings from Setting Healthcare's Environmental Agenda, October 16, 2000
- ◆ *Waste Reduction Guide*, Hospitals for a Health Environment (H2E): <http://www.h2e-online.org/tools/guide.htm> Designed to help healthcare sector waste managers develop an action plan tailored to their facilities.
- ◆ *Hospital Waste Prevention Tips*, NYC WasteLe\$\$ Program, A department-by-department list of tips to reduce waste developed by the NYC WasteLe\$\$ Program: <http://www.nycwasteless.com/gov-bus/Tips/hosptips.htm>
- ◆ *H2E Self Assessment Guide* (pdf), Hospitals for a Healthy Environment (H2E) <http://www.h2e-online.org/pubs/selfasmt.pdf>
- ◆ *Waste Reduction Case Studies*, Hospitals for a Healthy Environment (H2E) <http://www.h2e-online.org/tools/waste-case.htm>
- ◆ Presentation on infectious waste by West Virginia Department of Health: [www.wvdhhr.org/wvimw/presentations.asp](http://www.wvdhhr.org/wvimw/presentations.asp)

### Publications: WHO

- ◆ Safe management of wastes from healthcare waste activities: [http://www.who.int/water\\_sanitation\\_health/medicalwaste/wastemanag/en/](http://www.who.int/water_sanitation_health/medicalwaste/wastemanag/en/)
- ◆ Teachers Guide: Management of wastes from healthcare waste activities: [http://www.who.int/water\\_sanitation\\_health/medicalwaste/wsh9806/en/](http://www.who.int/water_sanitation_health/medicalwaste/wsh9806/en/)
- ◆ Health-care waste management rapid assessment tool (Excel format): [http://www.who.int/docstore/water\\_sanitation\\_health/Documents/Healthcare\\_waste/HCCWMtool\(3r\).xls](http://www.who.int/docstore/water_sanitation_health/Documents/Healthcare_waste/HCCWMtool(3r).xls)
- ◆ Wastes from health-care activities. Fact sheet 253, October 2000: <http://www.who.int/inf-fs/en/fact253.html>
- ◆ Decision-making guide for managing health-care waste from primary healthcare centres: [http://www.who.int/water\\_sanitation\\_health/medicalwaste/hcw/en/](http://www.who.int/water_sanitation_health/medicalwaste/hcw/en/)

- ◆ Review of health impacts from microbiological hazards in health-care wastes: [http://www.who.int/water\\_sanitation\\_health/medicalwaste/hcw2/en/](http://www.who.int/water_sanitation_health/medicalwaste/hcw2/en/)
- ◆ Review of health impacts from microbiological hazards in health-care wastes: [http://www.who.int/docstore/water\\_sanitation\\_health/Environmental\\_sanit/Healthcarewaste/healthimpacts.htm](http://www.who.int/docstore/water_sanitation_health/Environmental_sanit/Healthcarewaste/healthimpacts.htm)
- ◆ Aide mémoire for a national strategy for health-care waste management: [http://www.who.int/docstore/water\\_sanitation\\_health/Documents/Healthcare\\_waste/AideMem.pdf](http://www.who.int/docstore/water_sanitation_health/Documents/Healthcare_waste/AideMem.pdf)
- ◆ Teaching material to illustrate the Teacher's guide on the management of wastes from healthcare activities: [http://www.who.int/docstore/water\\_sanitation\\_health/medwaste/index.htm](http://www.who.int/docstore/water_sanitation_health/medwaste/index.htm)
- ◆ Guidelines for safe disposal of unwanted pharmaceuticals in and after emergencies: [http://www.who.int/docstore/water\\_sanitation\\_health/Documents/Healthcare\\_waste/Unwantedpharm/unwantpharm.doc](http://www.who.int/docstore/water_sanitation_health/Documents/Healthcare_waste/Unwantedpharm/unwantpharm.doc)
- ◆ Management of health-care wastes policy analysis: [http://www.who.int/water\\_sanitation\\_health/medicalwaste/en/Polanalysis.pdf](http://www.who.int/water_sanitation_health/medicalwaste/en/Polanalysis.pdf)
- ◆ Database on practical options for health-care waste management: <http://www.healthcarewaste.org/>

### **Publications: Srishti/Toxics Link**

- ◆ Lurking Menace: Mercury in the healthcare sector, June 2004
- ◆ Poster on managing mercury: Don't take mercury lightly, June 2004
- ◆ Flyers on medical waste: Your dental practice could be killing you and your family, June 2004
- ◆ Disposing immunisation waste in India: Policy Paper, August 2004
- ◆ Hospital waste: Time to Act – Srishti's factsheets on 14 priority areas, June 2002
- ◆ Managing hospital waste: A guide for healthcare facilities, September 2000
- ◆ Emerging experiences in medical waste management in India, 2000
- ◆ Poster on bio-medical waste management
- ◆ Medical waste issues, practices and policies, 1999
- ◆ Status of alternative medical waste disposal technologies in the US: A Srishti compilation to aid decision making by health care facilities, February 1996

**Publications : Health Care Without Harm**

- ◆ Disposal of mass immunisation waste without Incineration
- ◆ Non-incineration medical waste treatment technologies in the Europe
- ◆ Environmental health in the healthcare setting
- ◆ Update on pyrolysis
- ◆ Non-incineration medical waste treatment technologies
- ◆ World Bank's dangerous medicine: promoting incineration in third world countries
- ◆ Dentist the Menace? by Michael Bender
- ◆ Protecting by degrees: what hospitals can do to reduce mercury pollution
- ◆ Eliminating mercury discharge in hospital laboratories: a step towards zero discharge
- ◆ Preventing harm from phthalates, avoiding PVC in hospitals
- ◆ Green birthdays

# Notes

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