Management of biohazards: An occupational need

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Safety is necessary to protect staff and environment in a laboratory, and also to protect materials from possible cross-contamination. In most of the cases, biohazard waste handling by lower untrained staff in improper supervision and guidance results in damaging environment and transmit deadly diseases. This review presents development of waste management policies, plans and protocols in addition to establishing training programs on proper waste management for all healthcare workers.

Keywords: Biohazard, Biomedical waste, Regulation, Segregation, Waste management

Introduction

Biohazards are infectious agents or hazardous biological materials that present a risk to health of humans and animals directly through infection or indirectly through damage to environment. This can include medical waste or samples of a microorganism, virus or toxin from a biological source. Biohazards Unicode sign (U+2623) are generally used as a warning, so that those potentially exposed to biohazards may take precautions. This review presents handling of bio-medical wastes (BMWs).

Categorization of Biohazards

There are at least 193 important biological agents [viruses, bacteria, fungi, plant substances, invertebrate animals (mostly arthropods), substances derived from vertebrate animals and radioactive substances] that show infectious, allergenic, toxic, or carcinogenic activities in the working population. Risk is greatest among health care and laboratory workers (threatened by human pathogens, carcinogenic and radioactive substances), and among agricultural workers (at risk from dust-borne biological allergens and toxins and by parasitic worms in warm climates). There is growing evidence that biohazards are also important risk factors for many other professions, including woodworkers, workers of textile plants, sewage and compost workers, miners and renovators. United States’s Center for Disease Control and Prevention (CDCP) categorizes various diseases in levels of biohazard; Level 1 being minimum risk and Level 4 being extreme risk. An organism is considered to fall within biohazardous infectious material if it falls within World Health Organization (WHO) risk groups 2, 3 or 4 (Table 1).

Sources of Biohazards

Consign

Hospitals, universities & research institutes, bio-industry and butcheries, which deal with biohazardous material and/or generate biohazardous material/waste, are vulnerable places for biohazards and may become possible source for spread of infectious diseases among workers, waste handlers and common people due to lack of awareness about biohazards.

Humans & Animals

Occupational biohazards include viruses, bacteria, fungi and parasites, besides agents exerting allergic and toxic effects, which are directly responsible for development of various diseases in many occupational groups. Numerous agents of this group (allergens, microbial toxins, pollen allergens and allergens of animal origin) are components of bio aerosols-potential hazards inducing occupational respiratory diseases among farmers and people involved in other occupations. Biohazardous aerosols in a clinical environment are routinely generated in hospitals by man by breathing, coughing, sneezing, incubation, non-invasive ventilation, and delivery of
medication by nebulisation, surgery, feeding of patients, and sanitization of toilets. Everyday common cough experienced by all human beings is a very complicated process involving physiological, biochemical and aerodynamic aspects that determine transmission of virus, which, in turn, affects risk to others of contracting an infectious disease. A new coronavirus (SCoV) that evoked a rapid outbreak of disease described as severe acute respiratory syndrome (SARS) in the first half of 2003 was particularly common among health care workers. Novel viruses (zoonotic viruses, Nipah virus in pigs and Hendra virus in horses), Hantaviruses (Puumala, Hantaan, Sin Nombre and others) infecting field rodents are emerging in different parts of the world, may pose a particular threat to health and life of health care workers, agriculture workers and veterinarians. Prions responsible for inducing a zoonotic variant of Creutzfeldt-Jakob disease (vCJD) are considered to be a potential cause of work-related infections in agricultural and health care workers. Outbreak of bird flu and swine flu are extended due to infection through animals. During 8-14 June 2010, as many as 345 fresh cases of swine flu with 17 deaths were reported in India.

**Environment**

Agricultural settled dusts deposited during handling of various granular plant materials, which possess high concentrations of microorganisms and bacterial endotoxin, represent a potential hazard for workers. Hazardous bioaerosols, occurring in many work environments, pose an occupational health hazard of particular importance. Many new biological factors present in organic dusty that may induce work-related allergic and immunotoxic diseases among farmers and workers of agricultural and wood industries have been identified. Droplet aerosols, which are generated from water, oils, oil-water emulsions and other liquids in various work environments, may contain infectious agents (Legionella sp.) as well as allergic and/or toxic agents. It has been shown that allergens and endotoxins produced by Gram-negative bacteria occurring in oil mist from metal working fluids may cause occupational respiratory diseases in workers of metallurgic industry.

Hospital staff and waste handlers run highest risk of contracting disease from improper biomedical waste management practices. Prevalence rates of bronchitis, faucitis, varicella, pneumonia, allergic rhinitis, tuberculosis, varicella urticaria and hepatitis B among clinical staff are reported significantly higher and biohazard prevention (ventilation, sharp injuries control, and moisture control) need be strengthened in hospitals to prevent spread of infection. There is a particular concern about infection with Human Immunodeficiency Virus (HIV) and Hepatitis viruses B and C, for which there is strong evidence of transmission via health care waste that is generally transmitted through injuries from syringe needles contaminated with human blood. In 1992 in France, 8 cases of HIV infection were recognized as occupational infections. Two of these cases, involving transmission through wounds, occurred in waste handlers. In June 1994 in USA, 39 cases of HIV infection were recognized by the Centers for Disease Control and Prevention as occupational infections. Two of these cases, involving transmission through wounds, occurred in waste handlers. According to a 2007 CDC report, Methicillin-Resistant Staphylococcus Aureus (MRSA) is a leading cause of potentially life-threatening bloodstream infections and surgical-site infections and

<table>
<thead>
<tr>
<th>Group</th>
<th>Risk</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Worker risk - low</td>
<td>A microorganism that is unlikely to cause significant human disease.</td>
</tr>
<tr>
<td></td>
<td>Community risk - low</td>
<td>A pathogen that can cause human disease but is unlikely to be a serious hazard to workers or community. Workplace exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of pathogen is limited.</td>
</tr>
<tr>
<td>2</td>
<td>Worker risk - moderate</td>
<td>A pathogen that usually produces serious human disease but where pathogen does not ordinarily spread by casual contact from one infected individual to another.</td>
</tr>
<tr>
<td></td>
<td>Community risk - limited</td>
<td>A pathogen that usually produces very serious disease in humans is often untreatable, and pathogen may be readily transmitted from one individual to another.</td>
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was responsible for an estimated 94,000 life-threatening infections and 18,650 deaths in 2005. According to Federal Centers for Disease Control and Prevention, 90,000 patients die each year in USA from hospital-acquired infections – more deaths than those from breast cancer and AIDS combined and more than 2 million patients develop an infection during their stay.\(^\text{15}\)

**Biohazard Waste Management**

**Bio-Medical Waste (BMW)**

In accordance with BMW (Management & Handling) Rules 1998, deadline for GMC was 31st December’ 1999, failing which legal action can be initiated.\(^\text{16,17}\) Pathogens in infectious waste may enter body through puncture, abrasion or a cut in the skin, mucous membrane, inhalation and ingestion. Waste may be genotoxic (mutagenic, teratogenic or carcinogenic). This kind of waste includes certain cytotoxic drugs (drugs able to kill or stop growth of certain living cells), vomit, urine or faeces from patients treated with cytotoxic drugs, chemicals and radioactive materials. Improper BMW management also results in air, water and soil pollution, especially due to imperfect treatment and faulty disposal methods.\(^\text{17}\)

**Preclusion from Biohazards – Need of the Hour**

WHO states that 85% of hospital wastes are actually non-hazardous, whereas 10% are infectious and 5% are non-infectious but they are included in hazardous wastes. However 15-35% of hospital waste is regulated as infectious waste; range is dependent on total amount of waste generated.\(^\text{18,19}\) Modern hospitals and health care institutions including research centers use a wide variety of drugs including antibiotics, cytotoxics, corrosive chemicals, radio active substances, which ultimately become part of hospital waste. Such wastes are increasing in its amount and type due to advances in scientific knowledge and are creating its impact.\(^\text{20}\) Hospital waste, in addition to risk for patients and personnel handling these wastes, poses a threat to public health and environment.\(^\text{21}\)

Improper hospital waste management in India was first highlighted in a writ petition in the Hon’ble Supreme Court; and subsequently, pursuant to the directives of the court, Ministry of Environment and Forests, Govt of India notified BMW (Management & Handlings) Rules on 27th July 98; under the provisions of Environment Act 1986.\(^\text{16,22}\) Proposed hospital waste management plan is consistent with biomedical waste (management and handling) (second amendment) Rules, 2000, Ministry of Environment and Forests.\(^\text{19}\) These rules have been framed to regulate disposal of various categories of BMW as envisaged therein; so as to ensure safety of staff, patients, public and environment. Rules apply to all persons who generate, collect, receive, store, transport, treat, dispose or handle BMW in any form.\(^\text{19}\) Handling, segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of biomedical waste in any establishment.\(^\text{19,23}\) It includes following major steps for effectiveness of biohazards waste management.

**Step 1: Biohazard Assessment & Types of Biohazardous Waste Generated and/or Handled**

Commonly following types of biohazardous waste may be generated and/or handled: i) Cultures and stocks of infectious agents and associated biologicals, including laboratory waste, biological production wastes, discarded live and attenuated vaccines, culture dishes, and related devices; ii) Liquid human and animal waste, including blood and blood products and body fluids, but not including urine or materials stained with blood or body fluids; iii) Pathological waste including human organs, tissues, body parts other than teeth, products of conception, and fluids removed by trauma or during surgery or autopsy or other medical procedure; iv) Sharps include needles, syringes, scalpels, intravenous tubing with needles attached and any item that is sharp enough to penetrate skin and is contaminated with potentially infectious material; v) Contaminated wastes from research animals exposed to agents infectious to humans/animals; vi) Wastes generated in recombinant DNA research; vii) Radioactive waste; and viii) Animal carcasses and wastes generated in infectious disease research or recombinant DNA research.

**Step 2: Segregation, Packaging, Labeling and Collection of Biohazardous Waste**

Most appropriate way of identifying categories of BMW is by sorting waste into colour coded plastic bags or containers. BMW should be segregated into containers/bags at the point of generation in accordance with Schedule II of BMW (management & handling) Rules 1998.\(^\text{16}\)

General Methods – All biohazardous waste is to be packaged, contained in accordance with Schedule II and located in a manner that prevents and protects medical waste from release at producing facility at anytime before ultimate disposal. All primary containers (other than approved biohazard bags) used for medical
waste collection, storage and disposal are to be labeled with a biohazard symbol, or words “Medical Waste”, or “Pathological Waste” in letters not less than one inch high and also carry information prescribed in Schedule IV. These bags must be disposable and impervious to moisture, and have strength sufficient to preclude ripping, tearing, or bursting under normal conditions of usage and handling. No untreated BMW shall be kept stored beyond 48 h.

Waste Type-Specific Methods – All liquid cultures and stocks of materials contaminated with an infectious agent and associated biologicals, including laboratory waste, biological production wastes, discarded live and attenuated vaccines, shall be stored in closable, puncture-resistant containers for decontaminated by autoclaving. After autoclaving, liquid decontaminated waste can be disposed of in a sanitary sewer if no other hazardous materials (chemicals and/or radioactive materials) are present. All solid cultures and stocks of materials contaminated with an infectious agent, culture dishes and related devices other than sharps, can be stored in leak-proof, biohazard bags prior to decontamination. If rupture of bags or leakage is possible, the use of a secondary leak-proof container or bag is advised. Radioactive waste should be in sealable, robust containers, appropriately for their content and for normal conditions of handling and transportation. Containers should be label with International radioactive symbol. Animal waste contaminated with organisms infectious to humans shall be collected in biohazard bags or other leak-proof containers labeled with a biohazard sticker and disposed of by incineration. Animal carcasses generated in infectious disease research or recombinant DNA research will be stored in leak-proof containers labeled with a biohazard sticker and disposed of by incineration. Wastes generated in recombinant DNA research will be stored, treated and disposed of in the same manner as comparable waste types (liquid, solid, sharps) generated in infectious disease research.

All containers and equipment (refrigerators) used for storage shall be labeled with biohazard sticker or the words medical waste, or pathological waste in letters not less than one inch high. On site collection requires staff to close the waste bags when they are three quarters full either by tying the neck or by sealing the bag. Kerb side storage area needs to be impermeable and hard standing with good drainage. It should provide an easy access to waste collection vehicle.

Step 3: Transportation, Decontamination and Disposal of Biohazardous Waste

Transportation – Biomedical waste should be transported within the hospital by means of wheeled trolleys, containers or carts that are not used for any other purpose. Trolleys have to be cleaned daily. Off site transportation vehicle should be marked with the name and address of carrier. Biohazard symbol should be painted. Suitable system for securing load during transport should be ensured. Such a vehicle should be easily cleanable with rounded corners. Anything contained in Motor Vehicles Act, 1988, or rules thereunder, untreated BMW shall be transported only in such vehicle as may be authorized for the purpose by competent authority as specified by the government. Final treatment of BMW can be done by technologies like incineration, autoclave, hydroclave or microwave.

Decontamination – BMW shall be treated and disposed of in accordance with Schedule I and in compliance with the standards prescribed. Every occupier, in accordance with time-schedule in Schedule VI, shall set up requisite BMW treatment facilities like incinerator, autoclave, microwave system for treatment of waste, or ensure requisite treatment of waste at a common waste treatment facility or any other waste treatment facility. Suitably designed pollution control devices should be installed/retrofitted with incinerator to achieve prescribed emission limits. Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants. Toxic metals in incineration ash shall be limited within regulatory quantities as defined under Hazardous Waste (Management & Handling Rules,) 1989. Only low sulphur fuel shall be used as fuel in incinerator. Biohazardous waste, other than sharps and pathological waste, may be decontaminated by autoclaving with Bacillus stearothermophilus spores using vials or spore strips, with at least 1 x 10^4 spores per milliliter. Each autoclave shall have graphic or computer recording devices, which will automatically and continuously monitor and record dates, time of day, load identification number and operating parameters throughout the entire length of autoclave cycle.

Microwave should completely and consistently kill bacteria and other pathogenic organisms that are ensured by approved biological indicator at the maximum design capacity of each microwave unit. Biological indicators for microwave shall be B. Subtilis spores using vials or spore strips with at least 1 x 10^4 spores per milliliter. Microwave treatment shall not be used for cytotoxic,
hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.

Disposal – Blood, blood products and body fluids shall be disposed of by flushing down a sanitary sewer or Degraded by autoclaving and disposed of in landfill. For discharge into public sewers with terminal facilities, general standards as notified under Environment (Protection) Act, 1986 shall be applicable. By deep burial, a pit or trench (2 m deep) should be half filled with waste, then covered with lime within 50 cm of surface, before filling the rest of pit with soil. Pits should be distant from habitation, animal access and sited so as to ensure that no contamination occurs of any surface water or ground water. Area should not be prone to flooding or erosion. Biohazardous wastes, with exception of liquids and sharps that have been decontaminated by autoclaving, may be disposed of in lodal (dumpster) if they are securely packaged in leak-proof containers and biohazard warning labels have been removed or container is clearly labeled as decontaminated biohazardous waste. Decontaminated waste in biohazard bags with an autoclaved bag indicator must be placed inside an opaque plastic bag or other secondary non-transparent container (box) prior to disposal in lodal. It is imperative that waste is sufficiently autoclaved (darkening of indicator) prior to disposal. Only biohazard bags with the autoclaved indicator are approved for disposal. Human pathological waste shall be cremated or buried in a cemetery. Small pieces of tissue and fluids shall be ground until rendered unrecognizable and flushed down a sanitary sewer or incinerated. Sharps shall be disposed of by incineration. Place discarded needles and syringes into an approved sharps container. An approved sharps container is one that is leak proof, puncture-resistant, closable, bears biohazard symbol and is manufactured as a sharps container. Sharps containers used on campus should also be labeled sharps label to facilitate proper treatment and disposal of containers. Do not clip, bend, break, or recap sharps. Needles and syringes should be destroyed with the help of needle destroyer and syringe cutters provided at the point of generation. Infusion sets, bottles and gloves should be cut with curved scissors.

Awareness Program: Shortfalls in Training & Records

1. National Survey on Biohazard Control for Point-of-Care Testing (POCT) at US Hospitals

Main concerns about biohazard control for POCT are instrument contamination, cross-infection, and nosocomial infection (27%), and improper transporting, handling, or disposal of waste (27%)26.

2. An Epidemiological Study of Biohazards in Microbiology Laboratory at Large Teaching Hospital in Pune, India

A study conducted to find out epidemiological distribution of hazardous exposures during collecting, processing, and carrying out disposal of specimen at microbiological laboratories in Pune revealed that 50% of workers used incorrect method of specimen collection. In 16.2% cases, material remained on outside surface of container with a possible source of laboratory acquired infection. In 63.2% cases, none of the centrifuging tube was covered with cap, adding to a possible source of inhalation biohazards. In case of 3.6-28.9% workers, disposal method of used equipment was incorrect. Further in case of 32.5-42.5% cases, method of disposal of unused specimen was partially correct and was incorrect in case of 5-7% laboratory workers. Finally, 2% workers were found carrying out mouth pipetfitting27.


A study conducted in 2005 showed that there was no effective waste segregation, collection, transportation and disposal system in 30 hospitals with more than 30 beds. There is an immediate and urgent need to train and educate all doctors and staff to adopt an effective waste management practices28.

4. Hospital Waste Management — Awareness and Practices: A Study of Three States in India

A study conducted in urban / rural areas of Andhra Pradesh, Maharashtra and Uttar Pradesh in India in 2008, concluded that segregation and use of colour codes revealed gaps, which need correction. Access to common waste management facilities was low at 35%. Dumping BMW on roads outside hospital is still prevalent and access to common waste facilities is still limited. Training gained momentum only after dead-line for compliance was over. Surveillance, monitoring and penal machinery was found to be deficient and these require strengthening to improve compliance with the BMW management rules and to safeguard health of employees, patients and communities29.

5. BMW Management: A study of Knowledge, Attitude, and Practices in a Tertiary Health Care Institution in Bijapur

A study published30 in 2010 about knowledge, attitude and practice in a healthcare system suggested that there is need to periodically acquaint participants with updated BMW management and handling and strict supervision & surveillance be followed in day-to-day hospital waste management.
These studies indicate that there is need of proper training and guidelines to protect safety of patients, hospital staff and laboratory workers environment.

**Cost of Biohazard Management**

Cost of construction, operation and maintenance of system for managing biohazardous waste represents a significant part of overall budget of hospital/research laboratories if BMW (management & handling, BMW) Rules 1998 have to be implemented in their true spirit. Among two types (internal and external) of costs required to be incurred by hospitals for BMW management, internal cost is for segregation, mutilation, disinfection, internal storage and transportation including hidden cost of protective equipment, and external cost involves off site transport of waste, treatment and final disposal. Separate handling, treatment, and disposal of hazardous and non-hazardous wastes in different ways will reduce costs dramatically. Only the different kind of hazardous waste should be treated and disposed in a costly way instead of entire waste stream in a hospital. A budget should be incurred for arranging regular training and awareness program to upgrade skills for dealing with biohazard waste.

**Current Scenario in Developing Countries**

Biohazardous waste management is a serious public health concern. Globally this issue has been seriously considered and appropriate waste management systems are being developed and installed. In developing countries, compared to developed nations, management of infectious wastes has not received sufficient attention. Current system of healthcare waste management is underdeveloped and is in need of immediate attention and improvement.

General awareness among hospital/laboratory staff regarding BMW is lacking. According to the report prepared by Indian Institute of Management (IIM), Lucknow on behalf of Ministry of Environment in 2010, only 50-55% of BMWs is collected, segregated and treated as per BMW management rules. Rest is dumped with municipal solid wastes. Out of 42,0461 kg per day of waste generation, only 24,0682 kg is treated and as many as 14,959 hospitals have been served show cause notices as defaulters.

Untreated liquid waste from health institutions is let into drainage. Normally, waste is collected in open containers without disinfection. All biohazardous items used to absorb body fluids are collected in plastic or other non-specified containers. Waste is collected in mixed form. Some hospitals in the country have developed their own system of color coding. Waste sharps are discarded without disinfection and mutilation, which may result in their being, re-used thus spreading an infection. Waste collection and transportation workers in the hospital segregate recyclable material for sale. In a similar way, all disposable plastic items are segregated by waste pickers, from where waste is deposited either inside hospital grounds, or outside in the community bin for further transportation and disposal along with municipal solid waste. Since infectious waste gets mixed with municipal solid waste, it has potential to make the whole lot infectious in adverse environmental conditions.

Already established common BMW treatment facilities (170) for management of hazards is facing the problem, as many biohazardous generators do not adhere to the rules of segregation in to the container bags at the point of generation and are not labeled accordingly to schedule III of BMW (Management & Handling) rules, 1998. There are 391 incinerators, 2562 autoclaves, 458 microwaves, 145 hydroclaves and 6047 shredders in operation. Most of the incinerators are not properly operated and maintained, resulting in poor performance. Presently, there are 157 facilities, which are not adequate to handle all BMWs generated. Sometimes plastics are also incinerated leading to possible emission of harmful gases. Wastes from operation theatres, wards and pathological laboratories are disposed of without any disinfection/sterilization. Amputated body parts, anatomical wastes, and other highly infectious wastes are incinerated wherever incinerators are available; remainder is burnt in some corner of the hospital grounds, mostly in open pits.

Research laboratories are using infectious microorganisms, virus, toxins, radioactive substances and hazardous chemicals but not follow any policy for their management and disposal. In April 2010, recent incident of discard of radioactivity waste from Delhi University is live example of carelessness of such laboratories, which caused serious health hazards to many persons in Delhi.

**Suggestions and Implementations**

Following is required for immediate implementation: i) Existing hospitals, research institutes and other places, which are dealing and/or generating the biohazardous wastes, should be asked to implement BMW (Management & Handling, BMW) Rules 1998 in its true sense, failure of which should attract penalty as cancellation of license; ii) For any upcoming facilities
dealing and/or generating biohazardous wastes must not be granted license until it is proved by the fact and figures that facilities will implement and will adhere to the applicable law and it should also be made mandatory to have a separate department in any such facility to deal with biohazardous wastes along with associated responsibilities; iii) Training and awareness programs must be conducted on regular basis for potential affected population like hospital staff, health workers, waste handlers etc, and records should be maintained for training and equipments used for waste management; iv) Records of waste generation, treatment and disposal should be maintained by the all waste generated units; v) All equipments used for management hazards should confirm the design and emission norms as per rules; vi) New technologies have to be promoted for destruction of toxic wastes; Government is developing plasma technology for incinerating 50 tonnes per hour of BMW\(^{33}\); vii) Government must provide special funding to upgrade existing treatment facilities and to create new treatment facilities, wherever required along with separate dumping area for proper disposal; viii) Regulatory agencies, environmental agencies, hospitals administration, medical associations & municipal corporation should keep an eye for proper management of BMW in cities/towns; ix) Recommendation of IIM, Lucknow should be implemented that number of Common Bio-medical Wastes Treatment Facility (CBMWTF) has to be increased manifold\(^{33}\); x) Associated Chambers of Commerce and Industry of India (ASSOCHAM) has urged the states of Delhi, Haryana and Uttar Pradesh to pool in their resources to draft BMW disposal guidelines and recommended that three States should get together and identify places for setting up of centralised biomedical treatment plants through public-private partnership mode for disposal of medical wastes\(^{33}\).

Worldwide awareness has grown to impose stricter controls on handling and disposal of wastes generated by healthcare facilities. Maharashtra Pollution Control Board (MPCB) has fitted GPS devices on more than 140 of its trucks to trace their movement online. The system enables monitoring of vehicles’ movement on real-time basis and helps calculate number of trips of particular vehicles from pick-up source to dumping sites\(^{38}\) in order to check proper collection and disposal of BMWs to prevent environmental damage and health hazards. ASSOCHAM has proposed centralised bio-medical treatment plants and also called for setting up an independent body under Health and Family Welfare Ministry to look into proper treatment of medical waste in view of the over 700 large and medium hospitals, 2,300 diagnostic centres and nursing homes in Delhi and the NCR\(^{37}\). In a bid to keep a tab on increasing level of pollution, Haryana State Pollution Control Board (HSPCB) has issued directions to all institutions generating BMW to ensure handling of such waste without adversely affecting human health and environment. HSPCB has announced to impose heavy penalty on violators, punishment ranges from 5-year imprisonment to a penalty of up to Rs 1 lakh or both. In case, violation continues, it would then attract a penalty of Rs 5,000 per day up to one year and thereafter imprisonment up to 7 years\(^{39}\).

**Conclusions**

Technological progress has led to increased availability of health related consumer goods, which have propensity for production of increased wastes\(^{40-45}\). Advent of disposables in the hospitals has brought in inappropriate recycling, unauthorised and illegal reuse and increase in the quantum of waste. There is need of strict enforcement of legal provisions, regulations and environmental management system for procurement, storage, utilization and disposal of sensitive equipment and potentially hazardous materials. Hazardous wastes must be segregated into appropriate waste stream, utilizing either internal expertise or a hazardous waste broker\(^{46}\). Bio waste management should be supported through appropriate education, training and commitment of healthcare staff, management and healthcare managers within an effective policy and legislative framework\(^{36}\). With a rise in healthcare facilities and hospitals, Central Pollution Control Board has set a target to treat 17,97779 kg/d of BMW by 2012 and adequate common facilities to treat total waste generated in each state by 2022\(^{33}\).

In a recent study\(^{47}\), a new gene [NDM-1] (New Delhi metallo-beta-lactamase) makes bacteria highly resistant to almost all antibiotics, including carbapenems. Timothy Walsh from Britain’s Cardiff University and his team collected NDM-1 positive bacteria samples [Chennai, 44; Haryana, 26; Britain, 37; and in other sites in Bangladesh, India, and Pakistan, 73] from hospital patients and observed that as India provides cosmetic surgery for other Europeans and Americans, it is likely that NDM-1 will spread worldwide. To achieve the target of clean environment and to save valuable life, all should know and understand the value and strategy of management of biohazard.
References

4. Biosafety in Microbiological and Biomedical Labs, 5th edn (Centers for Disease Control and Prevention, USA) 2007.
11. The Times of India, 29.06. 2010 (Delhi edn).
38. Indian Express, com: find new superbug spreading from India, 11 August 2010.