

AN INTEGRATED BIOMEDICAL WASTE MANAGEMENT AND DISPOSAL PLAN FOR LARGE HOSPITALS OF LUCKNOW

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Abstract: The hospital wastes unless properly managed, may cause serious health problems. The infected portion of such wastes constitutes a very little portion and if properly segregated may provide a significant relief to the health related risks to which the hospital staff and the general public get exposed. A modification to the colour codes prescribed in the Rules as well as a comprehensive management plan, based on a comparative study of three prominent hospitals of Lucknow, for the management of bio medical wastes, are presented.

INTRODUCTION

Bio medical waste is generated during diagnosis, treatment, prevention of disease (and also research on human and animal diseases) in hospitals, clinics and laboratories, presenting occupational health risks to those who generate and come in to contact with it. There has been no scientifically practised method of treating biomedical waste in India. The usual practice of hospital waste disposal in India has been to dump it in municipal containers or throw it in open areas. This waste, treated as common waste by municipal authorities, is disposed off in uncontrolled or illegal landfills in vacant plots, slums, etc. posing environmental threats as anyone can easily be infected with diseases like Hepatitis B,C, HIV, plague, cholera and other infectious diseases. The rag-pickers scour the waste manually searching for recyclable material such as syringes, needles, PVC items, etc. which can be sold to unscrupulous recyclers. Most of such rag pickers are slum dwelling women and children and those from the lower socio economic strata and awareness of health risks amongst them is extremely poor. Hospital waste mixed with municipal solid waste also attracts stray animals who ingest polythene packets and sharps to die from internal hemorrhage or intestinal obstruction. Some hospitals install low cost incinerators to burn the medical waste to get rid of the infectious material. The incineration spews toxic emissions such as dioxins, furans, heavy metal and other harmful particulates, polluting the environment. A management plan for a safe disposal of the biomedical waste has been presented in this paper.

In India hospitals, generate waste at the rate of about 1-1.5 kg/bed/day¹ of which about 85 to 90% are non infectious wastes constituting general office waste, kitchen wastes, while 10 to 15% waste generated is infectious including used sharps pathological waste, syringes, needles, blood bags, plaster casts, dressings, drugs, chemicals etc. un-segregated infectious waste mixes with the non infectious waste, and the entire waste generated from the hospitals becomes hazardous. Segregation practices for proper management results in the reduction of infectious waste and also reduce the infrastructure requirement for the biomedical waste management. The Biomedical waste (Management and Handling) Rules² were issued which apply to all health care

facilities handling more than 1000 patients per month. The rules define biomedical waste as "any waste generated during the diagnosis, treatment or immunization of human beings or animals, or in research activities pertaining thereto, or in the production or testing of biologicals". The rules classified the hazardous biomedical wastes in to different categories and gave the basic principles for the proper management of biomedical wastes.

BIOMEDICAL WASTE MANAGEMENT

Appropriate waste management is necessary to avoid¹ injuries from sharps lead to infection to all categories of hospitals personnel and waste handlers². Nosocomial (hospital-acquired) infections in patients from poor waste management³ Risk of infections outside the hospital for waste handlers, scavengers and the general public⁴. "Disposable" being repacked and sold by unscrupulous traders without even being washed and drugs which have been disposed off, being repacked and sold to unsuspecting buyers¹. In this study, hospitals studied included (in descending order of size) Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGI), Command Hospital (Central Command) and Vivekanand Polyclinic in regard to the waste generation (Segregation, minimizing) waste disposal (deep burial, incineration, waste destruction, treatment) and a concern for the consequences (sustainable development)

Biomedical waste, a heterogenous mixture³ is very difficult to manage unless the problem can be simplified through (i) waste minimization; (ii) waste segregation; (iii) waste treatment on site (e.g. autoclave, hydroclave, chemical disinfection, microwave treatment etc.); (iv) waste transportation; (v) waste treatment off site (e.g. incineration, landfill disposal, etc.); (vi) final disposal. There is no single ideal treatment technology for treating biomedical waste. Facilities should select a treatment method after considering investment cost, maintenance and service cost, treatment effectiveness, destructive capability, hazardous nature of post treatment residues and environmental pollution.

Segregation of the waste at source - the key to the whole waste management process, should be carried out at the point of generation, to keep general waste from becoming infectious. If the infectious waste, which forms a small part of the hospital waste, is mixed with the other hospital wastes, the entire waste will have to be treated as infectious waste which is an expensive option. According to Amiyam⁴, it is about 16 times more expensive

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to dispose off infectious waste than it is to get rid of regular waste. Thus, by segregation, a hospital can (a) reduce total treatment cost, (b) reduce the impact of this waste on the community, (c) reduce the chances of infecting healthcare workers. It is essential that all sharps (whether infected or not), infected wastes not containing sharps, chemicals and pharmaceuticals other than cytotoxic drugs, other hazardous wastes are segregated by medical / paramedical personal and users and are kept separately in readily identifiable, preferably colour coded containers. Radioactive wastes, cytotoxic drugs and high pressure containers require special handling and disposal, The Ministry of Forests and Environment has notified as detailed in Table 1&2 the types of containers and their colour does for segregation of different categories of hospital wastes.

Table 1: Colour codes of Containers for segregation of solid wastes

Colour	Type of container	Waste category	Treatment options
Yellow	Plastic bags	Human and animals wastes, Microbiological and bio-Technological waste and Solid wastes (Cat.1,2,3&6)	Incineration /Deep burial
Red	Disinfected container / Plastic beg	Human and bio-technological waste and Solid wastes (Cat.3,6&7)	Autoclaving/ microwaving / chemical
Blue/white translucent	Plastic bag/ Puncture-proof container	Waste sharps and solid waste (Cat. 4 & 7)	Autoclaving / microwaving / chemical Treatment and destruction Shredding.
Black	Plastic bag	Discarded medicines, Cytotoxic drugs, incineration ash and chemical wastes (Cat. 5,9 & 10 Solids)	Disposal in secured landfills

Note:

- Colour coding of waste categories with multiple treatment shall be selected depending on the treatment option chosen.
- Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
- Categories 8 and 10 (liquid) do not need containers / bags.
- Category 3 is disinfected locally need not be put in to containers/bags.

Table 2: The proposed new categories of biomedical wastes for inclusion in Rules (2)

Waste category	Categories to be included	Colour code for container	Disposal/Treatment options
Anatomical waste	1 and 2	Yellow bag	Incineration / deep burial
Sharps waste	4	Blue puncture-proof container	Disinfection followed by mutilation and burial
Solid infected Waste(plastic And non plastic)	3,6 and 7	Red bag	Autoclaving, shredding and recycling
Liquid waste	8 and 10	Not applicable	Disinfection and discharge In to drains
Non-infected But hazardous waste	5 and 9	Black bag	Secured landfill

Incineration has long been the preferred method of treatment and destruction. However, increasing environmental concerns have resulted in controlled air emission regulations, making the cost of retrofitting existing incinerators, or buying new ones that meet tougher standards, increasingly high. Over the past two decades, incineration has been increasingly controversial due to its inability to safely handle the increased volumes of plastics, metals and pathogens. Daily variations in the composition and volume of hospital waste may cause toxic emission⁵. If the requisite temperature is not ensured, incomplete combustion can result in organic compounds such as dioxins (polychlorinated dibenzo-p-dioxins) furans (polychlorinated dibenzofurans), heavy metal vapours such as cadmium, mercury and lead, acid gases (hydrogen chloride, sulphur dioxide, nitrous oxide, etc). and other harmful particulates, polluting the environment besides causing a major public health hazard. They also produce toxic ash which needs special handling and disposal in a secured landfill. In 1985, 62% of the 137 hospital incinerators operating in Ontario were reported to be ill equipped to handle various components of biomedical waste⁴. Another study in Canada⁶ reported that many of the country's 120 hospital incinerators burn PVC, plastics, paper batteries and discarded equipment which leads to the emissions of dioxins, mercury and other toxins. According to the Environmental Protection Agency (EPA), medical waste incineration accounts for 10% of mercury emissions. In 1994, the US Environmental Protection Agency identified medical waste incinerators as the largest known source of dioxin in the US, emitting 5100 gm out of a total of 9300 gm of dioxin toxic equivalent released each year. Dioxin disrupts the endocrine, central nervous, immune and reproductive system and causes cancer. A June 1996 study at New York's Queens College, identified medical waste incineration as producing 48% of total dioxin deposited in then Great Lakes region of the US and Canada. Municipal waste incineration, the next largest source, accounted for 22%⁷. In 1987 German scientists reported that dioxin levels from medical waste incinerators could be twice that from Municipal incinerators. This may be attributed to higher levels of plastics, especially chlorine containing polyvinyl chloride (PVC) found in medical wastes, inadequate pollution control equipment such as scrubbers, etc. increase the start up and cooling down times, when dioxin formation is greatest. Reducing operational cost by reducing fuel consumption and charging (in batches) the incinerator before the required temperatures are attained, lead to incomplete combustion and associated air pollution problems. Dioxin formation can be reduced by removing all PVC from the waste prior to burning, installing stringent pollution equipment and through better training of staff. However, these measures increase the cost of incineration. In a study conducted in Portugal, Ferraz et.al.⁸ reported that even if correct operation and maintenance procedures are employed in the medical waste incinerators, the emission concentrations of dioxins are higher than the Portuguese emission limit. Several viable alternative technologies to incineration have been developed, like autoclave, hydroclave, hydroclave, microwave, pulverization etc. for these all categories of wastes, sharps, which include syringes, needles, cannula, glass, ampules, etc. have the highest disease transmission

potential because of the risk of transmitting blood borne infections through the percutaneous route. Almost 85% sharps injuries are caused during their usage and subsequent disposal; and more than 20% of those who handle them encounter needle-stick injuries⁹ requiring maximum precautions before disposal¹⁰. It is very important that all used disposable sharps must be immediately segregated in to a puncture – proof container made of thick plastic or metal having a narrow neck so that sharps once put inside cannot be removed easily. These containers should be taken to a central disposal unit where they are emptied. The sharps should be disinfected and mutilated (using a needle cutter placed in the department / ward) before finally disposing off in a sharps pit.

Every healthcare facility should have well planned awareness and training programmes (in appropriate language medium) for all categories of personnel including doctors, nurses, chemists, laboratory technicians, hospital engineers, cleaning supervisors, sanitary inspectors, cleaning staff, etc. In India, such waste handling is generally and solely left to the poorly educated and lowest category of untrained workers. The basic contents of training programmes should include information on: (1) waste related health hazards, (2) methods of preventing the transmission of nosocomial or hospital acquired infections related to waste handling methods, (3) safety procedures for dealing with chemical, pharmaceutical and radioactive wastes and sharps, (4) proper waste segregation, handling, packaging, transport and disposal, and (5) action and notification to supervisors in case of accidents.

COMPARISON BETWEEN THE WASTE TREATMENT AND DISPOSAL SYSTEMS OF THE VARIOUS LUCKNOW HOSPITALS.

Table 3 contains various informations in regard to the comparison of the hospitals is presented in regard to the segregation of waste, treatment of sharps, incineration facilities and other facilities. At SGPGI, no segregation of waste takes place except for sharps. The hospital has introduced a system of colour coded containers for segregation of waste but in one ward only. This facility needs to be expanded to other wards as well. All waste (except sharps) is collected in black plastic bags and taken for incineration. This practice increase the bulk of infectious waste manifolds. The Command Hospital (Control command CH/CC) has devised its own colour coded system for segregation of wastes according to the colours of buckets available in the local market. Charts have been put up in different wards to specify the type of waste to be put in each colour bucket. Though this system is not in accordance with the Rules, but at least the waste is being segregated and treated, and unlike the SGPGI, the entire waste generated in the hospital is not rendered infectious. Vivekanand Polyclinic follows the Biomedical Waste Rules closely as waste is segregated in different specified coloured bins. This has been made possible due to a WHO sponsored and funded project. Charts have been displayed to educate and train hospital personnel, patients and their relatives to appropriately put the waste in the bins. It is

Table 3: Comparison Between Waste Treatment and Disposal Systems in the Various Lucknow Hospitals

System	SGPGI	Command Hospital (Central Command)	Vivekanand Polyclinic
Segregation of waste	segregation only for sharps. In 3 colour coded containers in one ward.	Segregation according to colour code system of buckets, locally.	Proper segregation is according to the prescribed colour codes.
Treatment of sharps	Sharps segregated at the site of generation, taken to Central Sharps Disposal Unit, where the needle tips are burnt and syringe nozzles are cut.	Sharps segregated at the site of generation, put in disinfectant needle tips are burnt and syringes nozzles cut at the site of generation.	Sharps segregated at the site of generation. put in disinfectant, needle tips are burnt and syringe nozzles cut at the site of generation.
Incineration	All waste except sharps incinerated plant is of direct incineration type; no devices are available to measure the temp. pressure, gaseous emissions, etc.; stack height of 30 m is in accordance with the Rules.	Beehive incinerators used for incineration of pathological waste and waste contaminated with blood, body fluids, etc.; no devices are present to measure temp. pressure, gaseous emissions, etc.; stack height is insufficient.	Incinerator not available; pathological waste sent to LNN incinerator site.
Other facilities (Microwave, hydroclave, blood bag, shredder, etc.)	None available except autoclaves in the Microbiology Dept, where items such as glassware, test tubes, etc. are autoclaved and reused.	Autoclave and shredder for plastic hazardous waste then shredded and sent for recycling; microbiology waste is autoclaved; glassware is reused.	The Biomedical Waste Management Complex houses a blood bag shredder, autoclave, microwave and shredder, for treatment and disposal of waste.

perhaps coincidental that higher the hospital, poorly is the management in regard to the segregation of waste in Lucknow. All the three stated hospitals follow good sharps management practice of segregation and disinfection of sharps at the site of generation. The needle tips are burnt using a needle syringe terminator and the nozzles are cut. This ensures that the syringes and needles are not reused or recycled. SGPGI has a Central Sharps Disposal Unit where all sharps are collected centrally and destroyed. This has the advantage of using fewer needle syringes terminators for the entire hospital. It also ensures better supervision, maintaining better quality control and a longer life for the equipment. SGPGI has its own incinerator where the entire waste of the hospital (except sharps) is incinerated. Its stack height is sufficient (30 mm) but there are no control devices for maintaining temperature, pressure, gaseous emissions, etc. The incinerator therefore, does not follow the specifications of the Biomedical Waste Rules CH(CC) uses four beehive incinerators for pathological waste and wastes contaminated with blood, body fluids, pus, etc. such as cotton, bandages, plaster casts, etc. The temperature attained is only 300-400° CF which is not sufficient for proper incineration. Stack height is also insufficient. Vivekanand Polyclinic does not have an incinerator and uses the common Lucknow Nagar Nigam incinerator for disposal of pathological waste, which is very small in quantity as the waste is properly segregated. Improperly operated individual incinerators cause more harm than good to the environment because of emission of carcinogenic gases such as furans and dioxins. SGPGI and CH(CC) should also therefore utilize the services of common incinerators or operate their own properly.

SGPGI does not possess waste treatment facilities such as microwave systems, blood bag shredders, hydroclaves, shredders, etc. The Microbiology Department has two horizontal autoclaves used to disinfect glassware, Petri dishes, test tubes etc. These are subsequently reused after disinfection. All other waste form the hospital (except sharps) is incinerated without segregation. The hospital authorities are aware that their management practices are not up to the mark and plan to give the entire waste management and disposal to an external agency are not up to the mark and plan to give the entire waste management and disposal to an external agency on lease basis. CH(CC) utilizes an autoclave and shredder for the plastic hazardous waste. This is subsequently sent for recycling. The Microbiology Department reuses its glassware after autoclaving. However, no equipment such as hydroclave, microwave or blood bag shredder is present in the hospital. Vivekanand Polyclinic has the most comprehensive treatment and disposal system for different categories of waste. There is a microwave System, autoclave, blood bag shredder and shredder. The segregated waste is treated according to the specification in the Rules. The plastic waste is recycled is sent for landfilling after proper treatment. Other hospitals should follow the example set by Vivekanand Polyclinic regarding the proper treatment and disposal of their waste. The Polyclinic has demonstrated that with effort and intention, proper management of waste in hospitals is possible. It seems that in Lucknow, bigger the hospital lesser is the concern for public health and environmental pollution.

WASTE MANAGEMENT PLAN

A comprehensive waste plan for proper treatment and disposal of different types of hospital wastes is proposed and presented., *Some recommendations for modifications in the biomedical waste (Management and Handling) rules 1998(2)*

To enable the Rules (2) to be conveniently followed by all healthcare establishment, following *recommendations* are advocated.

- ◆ For the purpose of treatment and disposal, the waste categories (2) should be reduced from 10 to 5 as detailed in Table 2
- ◆ Heavy duty coloured plastic bags according to the prescribed colour code should be provided for uniformity by the government at fixed rates.
- ◆ Costly machines for disinfection of waste and final disposal such as central incinerators, autoclaves, microwave, hydroclave, etc. must be made available centrally by the Govt. of Pollution Control Boards where the

hospital waste can be treated and disposed off, at reasonable rates on sharing basis. For this, Common Biomedical Waste Treatment, facilities need to be installed in all cities.

- ◆ The Pollution Control Board should regularly and periodically sponsor training programmes in proper management of biomedical wastes.

CONCLUSION

Bio medical waste, if not properly managed and / or treated, can lead to epidemic like situations. Large hospitals generate a lot of waste of which only about 15 percent constitute the infected biomedical waste which when mixes with the general waste, the entire waste becomes infected causing serious management and safe disposal problems. Sharp constitutes the most dangerous component of biomedical wastes because of risk and dangerous infections of Hepatitis B, C and HIV associated with needle prick injuries.

There are many technologies available for the proper treatment and disposal of biomedical waste. Incinerations which causes serious air pollution problems is gradually being replaced by other technologies such as autoclaving, microwaving, hydroclaving, chemical treatment with shredding, etc. all over the world. Waste minimization techniques and training of staff can be a very effective solution to reduce the management costs for the already cash starved hospitals. Private entrepreneurs are now taking keen interest in the field of biomedical waste management.

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LITERATURE REVIEW

Prospective Study of Progression of Kidney Dysfunction in Community – Dwelling Older Adults

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Few prospective studies have assessed renal dysfunction in order persons. We sought to define kidney dysfunction among a community based cohort of elderly subjects and to determine the factors for its progression. The Epidemiologia do Idoso (EPIDSO) Study is a prospective study of individuals > 65 years old (mean 72.6+0.3) living in the community in the city of Sao Paulo. The creatinine clearance (CrCI) of 269 individuals of this cohort was estimated during 8 years of follow – up. The rate of decline in CrCI was calculated using linear regression analysis and dividing the group in to tertiles of CrCI change. Overall mean change in CrCI was -2.37 + 0.23 mL/min per year. Mean age increased with the greatest degree of decline in renal function (71.1+ 0.59, 72.5+0.59, 72.5+0.54 and 74.3+0.58, for the first, second and third CrCI change tertile, respectively, P<0.071). A higher value of baseline CrCI was associated with progressive decline in CrCI (P<0.01). Diastolic BP was greater in the second versus the first estimated glomerular filtration rate tertile (83+1 vs 80+1 mmHg, P<0.05) High density lipoprotein (HDL) cholesterol was inversely associated with CHO decline (P<0.05) Progression of kidney dysfunction occurs in most community dwelling elderly. Strategies aimed at showing the progression should be considered for possible risk factors of older age, baseline CrCI, BP and HDL