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Fate of hospital waste in India

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Abstract
Hospitals being the centre of cure are also an important centre of infectious waste generation. Present study deals with the study of the fate of the hospital waste at national and international level. An exhaustive survey and detailed investigation of the waste generated, recycled and their disposal procedures adopted in the leading hospitals in Terai belt of Uttar Pradesh in India have been reported through a "Self Assessment Audit Form" which consisted of 122 parameters divided in to 33 broad categories. It has been found that the amount of the infectious components in the waste is very little and this needs careful handling. Norms prescribed by the government for the disposal of hospital waste has also been discussed. In most of the cases it was found that regulations were being violated.

Keywords: Hospital waste, incineration, pollution, hospital management, hazards.

Introduction

Hospitals generate large amount of dangerous waste. If not managed properly, these dangerous wastes can threat to the public safety. Proper management of chemicals and wastes can help prevent serious consequences of these hazardous wastes. During the service to humanity hospitals release large amount of waste, and the quantum of these waste material depend on the strength of that particular nursing home. Some hospitals or pathological laboratory wastes may contain toxic chemicals, like mercury, xylene and formalin. Due to the morbid population hospitals and diagnostic centers are fast increasing in the country and these are providing medical services to a greater number of people. During these medical services the use bandages, syringes, human tissues, used culture media containing microorganisms are dumped in the open bins on the roadsides or low lying area or directed into the water bodies (Dwivedi *et al.*, 2006). A biomedical waste which is hazardous in nature is potentially capable for the transmission of communicable diseases.

All waste materials which is generated by hospitals are not hazardous in nature but only a part of these wastes are infectious which is laden with fatal microorganisms of many serious contagious diseases, which easily spread into the water bodies and air (Dwivedi *et al.*, 2009). It is true that health facilities are highly advanced, now days, but with the increasing health facilities many modern incurable diseases are also approaching. Previously, when professional health care centers were not popular then the treatment totally depended on medicinal plants, which is presently known as herbal treatment. Those herbal treatments had short comings of being insufficient for severe diseases. But, owing to this natural treatment the pollution rate was also low. Presently, in modern era for treatment of these diseases many advanced type of drugs and medicines, which are made up of highly toxic substances are recommended, these are carcinogenic and cytotoxic in nature if not handled safely (Dwivedi *et al*., 2006). Now a day, to overcome these biomedical hazardous waste disposal problems, many rule and regulations have been formulated.

Every coin has two sides, so is here in the case of hospitals also. Nowadays, due to the population explosion generation of biomedical waste is in a voluminous amount. Proper management and handling of these huge amounts of hazardous waste are of prime importance today. To minimize these problems many efforts have been done or are being done at the international level. For safe and scientific management of biomedical waste, handling, segregation, mutilation, disinfection, storage, transportation and finally disposal are vital steps for any health care institution. In developed countries these vital steps are being adopted by

all the institutions related to the health problem (Acharya and Singh, 2000).

The minimization and effective management of biomedical waste is through identification and segregation of the hazardous waste. To tackle the problem of identification of biomedical waste different types of colour code plastic bags or containers are used which is the most appropriate way (Dwivedi *et al*., 2008). Sharps should be collected in puncture proof bags or containers. Highly infectious waste is to be sterilized before dumping with general waste. Needles and syringes are to be destroyed with the help of needle destroyer and syringe cutters at the point of generation. All disposable plastics should be subjected to shredding before disposing off to vendor. The ultimate treatment practices of biomedical waste are incineration, autoclaving, hydroclaving or microwaving.

Materials and Methods

In the light of hospital waste management four hospitals in the Terai belt of Uttar Pradesh were selected as the study sites. District Hospital Gorakhpur was selected as the study site-1; Baba Raghav Das Medical College and Hospital, Gorakhpur was selected as the study site-2; District Hospital, Basti was noted as the study site-3 and site-4 was the Sanjeevani Nursing Home, Gorakhpur. Study sites 1, 2, and 3 were government organizations, while the study site 4 was a private nursing home. The selected study sites have been surveyed regarding facilities; types of waste generated i.e. solid, liquid, reuse, their collection areas, way of disposal etc. The study was carried out by collecting information through the "Self Assessment Audit Form" (Table: 1). To bring out the exact figure, this "Self Assessment Audit Form" was equipped with 122 parameters divided in to 33 broad categories. Further, detailed analysis regarding the total hospital activities such as, total outdoors, indoors, pathological investigations etc. on monthly basis was conducted at the study site-1.

Results and Discussion

Information given by the institutions revealed that most of the hospitals generate solid and liquid wastes of different natures, some of which are hazardous as well. All surveyed institutions have labeled collection container with color coding (Red, Black, Yellow, White or Blue) for collection of different types of wastes, according to the nature of wastes. All institutions have a central collection area. Government institutions have conducted training program to train their staff about safe handling of biomedical waste but it is not known about the study site-4. Thus three of the selected institutions have trained staffs who are handling biomedical wastes. None of the institutions were found to have a record for the amount of wastes they are generating. Government health institutions of Uttar Pradesh have recently made a contract with a private organization for proper transport and disposal of hospital wastes generated by different institutions through out the state.

None of the institutions have been found in practice to reduce, eliminate and recycle their toxic chemicals, equipments and materials return program. Though all the institutions have mercury containing equipment and equipments falling under universal waste (batteries, lamps, mercury, and thermostats) but none had the proper facility to prevent release of these to the environment. Every institution has claimed that they have proper labeling and segregation of their dangerous wastes through labeled containers at central storage systems. None of the institutions are found to recycle their used articles like paper, aluminum cans, card board, steel cans, sharps, news paper, toner cartridges, solvent, fixers, pallets, inkjet cartridges, wood, printer ribbons, lead aprons, motor oils, pharmaceuticals, box board, computer, ice packs, coolers, glass, silver recovery, construction wastes, mercury, X- ray films, batteries, plastics, alkaline, nickel, cadmium and lead acid (Table: 1). Three out of the four surveyed institutions claim to have on-site incineration facility. The disposal of their red bag waste is performed through on-site incineration. Autoclaving or other methods of disposal are not in practice in any of the selected institutions. A record regarding the production of extremely hazardous substances, amount and the types of wastes is not maintained by any institution. Like wise, there is no reporting system of these records to higher authorities. Certain articles and instruments for e.g. patient dishware, employee dishware, glass ware, baking pans, metal trays, bath basins, bed pans, urinals, pillows, instruments pans, splash basins, ,medicine cups, gowns towels, drapes, ventilator tubing, pulse oximeters, suture removal kits and vaginal speculum are reused by health institutions.

Table 1: Survey report of the selected hospitals (Study Sites= SS)

	Parameters	SS-1	SS-2	SS-3	SS-4
1.	Do departments generating dangerous wastes have satellite accumulation areas?	√	√	√	√
2.	Are the collection / satellite areas properly & clearly identified & labeled?	√	√	√	√
3.	Does your hospital have a centralized collection area for dangerous waste?	√	√	√	√
4.	Are all waste containers properly labeled with type of dangerous waste & accumulation start date?	√	√	√	√
5.	Do staffs who handle waste receive hazardous waste management training?	√	√	√	X
6.	Does your department keep record of the amounts of dangerous waste generated per month?	X	X	X	X
7.	Does your hospital use a hazardous waste firm to service, properly transport, & dispose of your dangerous waste?	√	√	√	NC
8.	Has your facility worked to reduce, eliminate, & recycle toxic chemical, equipment and materials or use pharmaceuticals return programs whenever possible?	X	X	X	X
9.	Does your hospital handle universal wastes (batteries, lamps, mercury thermostats etc.) separately from your other hazardous waste?	X	X	X	X
10.	Does your hospital properly store universal waste in appropriate containers that prevent release to the environment?	X	X	X	X
11.	Does your facility ensure that medical wastes are labeled and managed properly segregated from dangerous wastes and solid wastes?	√	√	√	√
12.	Are all biomedical waste containers labeled “Biomedical Waste”?	√	√	√	√
13.	Do you recycle any of the following -				
a.	Paper white.	X	X	X	X
b.	Paper coloured.	X	X	X	X
c.	Aluminum cans.	X	X	X	X
d.	Card board.	X	X	X	X
e.	Steel cans.	X	X	X	X
f.	Sharps.	X	X	X	X
g.	News paper.	X	X	X	X
h.	Toner cartridges.	X	X	X	X
i.	Solvent / Fixers.	X	X	X	X
j.	Pallets.	X	X	X	X
k.	Inkjet cartridges.	X	X	X	X
l.	Wood.	X	X	X	X
m.	Printer ribbons.	X	X	X	X
n.	Lead aprons.	X	X	X	X
o.	Motor oils.	X	X	X	X
p.	Pharmaceuticals.	X	X	X	X
q.	Box board.	X	X	X	X
r.	Computers.	X	X	X	X

s.	Ice packs /Coolers.	X	X	X	X
t.	Glass.	X	X	X	X
u.	Silver recovery.	X	X	X	X
v.	Construction waste.	X	X	X	X
w.	Mercury.	X	X	X	X
x.	X-ray films.	X	X	X	X
y.	Batteries.	X	X	X	X
z.	Plastics.	X	X	X	X
A1	Alkaline.	X	X	X	X
A2	Nickel cadmium.	X	X	X	X
A3	Lead acid.	X	X	X	X
14 a.	Does your hospital dispose of its red bag waste through off- site incineration?	X	X	X	NC
b.	Through on- site incineration.	√	√	√	X
c.	Through autoclave.	X	X	X	X
d.	By other processes.	X	X	X	X
15.	Does your hospital have on site listed Extremely Hazardous Substances (EHS) in any amount over the threshold reporting quantity?	X	X	X	X
16.	Does your hospital reuse any of the following?				
a.	Patient dishware.	√	√	√	√
b.	Employee dishware.	√	√	√	√
c.	Glass ware.	√	√	√	√
d.	Baking pans.	√	√	√	√
e.	Metal trays.	√	√	√	√
f.	Bath basins.	√	√	√	√
g.	Bed pans.	√	√	√	√
h.	Urinals.	√	√	√	√
i.	Pillows.	√	√	√	√
j.	Instrument pans.	√	√	√	√
k.	Splash basins.	√	√	√	√
l.	Medicine cups.	√	√	√	√
m.	Gowns towels.	√	√	√	√
n.	Drapes.	√	√	√	√
o.	Ventilator tubing.	√	√	√	√
p.	Pulse oximeters.	√	√	√	√
q.	Suture removal kits.	√	√	√	√
r.	Vaginal speculum.	√	√	√	√
17.	Does your waste water go to				
a.	Sewer.	√	√	√	√
b.	Septic system.	NC	NC	NC	NC
c.	Surface water.	NC	NC	NC	NC
18.	If so, what is your discharge per day (in gallons)?	NC	NC	NC	NC
19.	How many discharge points?	NC	NC	NC	NC
20.	Have you sampled your waste water discharge?	X	X	X	X
21.	Do you have a discharge permit or authorization to discharge a pollutant permit number?	X	X	X	X
22.	Do you have a diagram of your sewer discharge?	X	X	X	X
23.	Does your facility discharge dangerous waste down the drain?				

	If so, list dangerous waste(s).	√	√	√	√
24.	How much dangerous waste do you discharge?	X	X	X	X
25.	Has your hospital implemented a water conservation program?	X	√	X	X
26.	Does your facility have a meter to monitor total water usage?	X	X	X	X
27.	Does your hospital use any of the following water efficient equipment or practices?				
a.	Low- flow toilets.	NC	NC	NC	NC
b.	Re-circulated water.	X	X	X	X
c.	Regular inspection and repairs of leaks.	√	√	√	√
d.	Flow control mechanisms.	X	X	X	X
28.	What facilities are at this site?				
a.	Dental.	√	√	√	√
b.	Amalgam separators.	X	X	X	X
c.	Filters.	X	X	X	X
d.	Equipment maintenance schedule.	√	√	√	√
e.	X-ray / photography.	√	√	√	√
f.	Digital.	X	√	X	X
g.	Silver recovery.	X	X	X	X
h.	Recycle film.	X	X	X	X
i.	Labs.	√	√	√	√
j.	Pathology.	√	√	√	√
k.	Histology.	X	√	X	X
l.	Testing.	√	√	√	√
m.	Pharmacy.	X	X	X	X
29.	Any compounding?				
a.	Laundry.	√	√	√	√
b.	Water recycled.	X	X	X	X
c.	Kitchen.	√	√	X	X
d.	Grease trap.	X	X	X	X
e.	Phosphorus free detergents (type).	X	X	X	X
f.	Boilers.	X	X	X	X
g.	Grinder.	X	X	X	X
h.	Vehicle or equipment maintenance.	√	√	√	√
i.	Washing.	√	√	√	√
j.	Solvents.	X	X	X	X
k.	Waste oil.	X	X	X	X
l.	Oil / water separator.	X	X	X	X
m.	Sterilization.	√	√	√	√
n.	Disinfection.	√	√	√	√
o.	Discharge chemicals to sewer.	NC	NC	NC	NC
p.	Grounds- keeping.	X	X	X	X
q.	Irrigation system.	X	X	X	X
r.	Audit water of irrigation system.	X	X	X	X
30.	Has your hospital evaluated alternatives to polyvinyl chloride (PVC) and di ethyl hexyl phthalate (DEHP) containing products?	X	X	X	X
31.	Does your hospital purchase nontoxic / less toxic alternatives for janitorial chemicals?	X	X	X	X
32.	Does your hospital use ethylene oxide?	X	X	NC	NC

33.	Dose your hospital purchase Energy Star equipments?				
a.	Computer.	√	√	√	√
b.	Monitors.	√	√	√	√
c.	Scanners.	X	√	X	X
d.	Fax machine.	√	√	X	X
e.	Water coolers.	√	√	√	√
f.	Printers.	√	√	√	√
g.	Copiers.	√	√	√	√
h.	Commercial refrigerator / freezers.	√	√	√	√

NC: No Comment.

Regarding liquid wastes, all the selected institutions are found discharging their waste water directly into the sewer system. Quantitative amount of waste water discharge per day is not in their record. No comments regarding the magnitude of waste water being discharged per day, number of discharge points in their institutions was provided and neither any diagram of their sewer system was available. Physico-chemical property of the waste water being discharged has never been analyzed. None of the surveyed institution was authorized to discharge polluted water, but all the institutions were found directly discharging their dangerous waste down to the drain. Water conservation is being practiced only at Baba Raghav Das Medical College in Gorakhpur. Instrument for monitoring total water used is not installed in any institutions. They have no comment about low flow toilets. Recycling of water is not being done in any institution but regular inspections and repair of leaks are in practice.

Regarding facilities available at the institutions dental facility is at every institution. None of the institutions have Amalgam separators, Filters, Silver recovery, Recycle film, Pharmacy, Boilers, Grinder, Solvents, Waste oil water separator, Grounds keeping, Irrigation system, Audit water of irrigation system and Grease trap. Equipment Maintenance Schedule (EMS), X- ray Photography Laboratory, Pathology, Laundry, Vehicle or equipment maintenance, Washing, Sterilization; all these facilities are available at all the institutions. Facilities like Histology and Digital photography are in practice only at Baba Raghav Das Medical College, Gorakhpur. Facility like Kitchen is in two out of the four selected study sites. All the selected hospitals are using computer, copier and printers but scanners are being used at only of the selected study site. At the same, time fax machine is being used only at the two sites. Also, all the selected hospitals are using water cooler, refrigerator and freezers.

Though, it was an exhaustive survey but authors feel that the hospital authorities found them-selves uncomfortable to disclose their facts. It was not an easy task to drag the information. The self audit form has also its limitations. Information regarding the assistance from Government, financial flow and the annual budget could not be incorporated in the self audit form because of certain limitations. These studies may be done as another part of the study.

A case study of District Hospital Gorakhpur

To conduct the detailed investigation, district hospital Gorakhpur was selected for evaluation of the magnitude of the hospital waste generated. The record of one year (2006) for total indoor, total outdoor patients and related investigations such as pathology x-rays and ultra sonogram have been summarized in table 2. On the ground of the table it was found that the hazardous waste is generated from orthopedic, indoor surgery and pathology. X-ray and ultra sonogram were the process through which excess of heavy metals like silver (Ag) is released. Since, 600 gram hospital waste is generated by single patient on an average, therefore 9259 patients (table 2) would produce 5555.4 kg of hospital waste in a year and this is a projected estimation.

Table 2: Record History of District Hospital, Gorakhpur

Months	Total Outdoor	Total indoor (Medi., Surg., Ortho. etc.)	Investigation		
			Pathology	X-Ray	U.S.G.
January	20887	822	1376	876	-
February	21216	869	1862	880	19
March	24191	903	1669	1196	62
April	20775	536	1112	984	64
May	21717	525	845	1123	-
June	23667	622	905	1229	-
July	25218	548	1048	1045	-
August	24295	814	1152	1051	-
September	24425	862	1317	987	21
October	20966	978	1061	320	34
November	25104	949	1289	1104	50
December	21485	831	949	807	36
		Total = 9259			

Cause of the Problem

In India, excepting a few large hospitals, most of the smaller hospitals and nursing homes lack any effective system to safely dispose off their waste. Even the Government and municipal hospitals are no better than the private nursing homes, regarding disposal of their waste. Thus, an unauthorized reuse of medical wastes by rag pickers is being promoted through irresponsible dumping of these dangerous wastes into open bins. Biomedical waste, because of its infectious nature and serious health hazards need care for its proper collection, segregation and disposal to minimize the pollution of air, water and soil (Singh and Sharma, 1996). For this, government of India has laid down certain rules which should be enforced by authorities and should be strictly followed by institutions and clinics in the welfare of mankind and the safety of animals.

Central Pollution Control Board and the State Pollution Control Boards, the agencies responsible to enforce these rules in hospitals are on one hand lacking adequate power and on the other hand there is no commitment. As a result, most of the large hospitals have not complied with these rules even after expiry of new deadlines. In such situation NGO's and voluntary bodies have to come forward and compel the hospitals and nursing homes to fall in the line with the rules.

Remedial Measures

Biomedical waste management is of paramount importance at each level. In India Andhra Pradesh, Bihar, Uttar Pradesh and Tamil Nadu are four states which play a key role in the generation of voluminous amount of hazardous solid waste. In India, adequate and requisite number of sanitary landfills is lacking. Therefore, the biomedical waste are openly dumped into the open bins on the road sides, low lying area or they are directed into the water bodies; through which severe disease causing agents are spread into the air, soil and water. This would result into the incurable diseases like AIDS and Hepatitis B. Rule 1998 and seventh schedule of Indian constitution are related to the hazardous waste management program. These rules are to be strictly enforced by the Central Pollution Control Board (CPCB). Waste means anything which is not intended for further use or reuse. But here in the case of solid waste materials, released by the health care institutions or nursing homes may further be used after minimizing or reducing its infectivity.

In developed countries, these waste materials are treated with the different kinds and strength of chemicals to minimize its pathogenicity and then used in the power production. Medical waste has a broad stream; it includes all types of waste materials like waste from offices, kitchen, canteen, cafeteria, pathology and also from different wards. All these are not infectious in nature only some of these are perilous in nature. The waste materials are also divided into two categories on the basis of their degradability.

Hospital wastes carry to a greater extent of harmful disease causing microscopic organisms. Proper management and disposal of

biomedical waste is of utmost importance because of its pernicious and contagious nature. Aseptic vermicomposting is more efficient method for management of biomedical hazardous waste. Bio-oxidation and stabilization of organic or biodegradable matter is carried out with the help of a special type of earthworms which reproduce at a faster rate. The biomedical waste management by safe, cheap and easy methods needs no further emphasis. Hospital waste are hazardous in nature thus before its mixing with the general waste it should be properly freed from pathogens.

Conclusion

Thus, concluding the topic, as per survey report, health institutions are generating biomedical wastes including hazardous and dangerous waste in the form of solid and liquid. For solid wastes, they have facility of accumulation, segregation through labeled and coloured containers and they also have facilities of central storage. Staffs of the government health institutions are trained to handle the waste but in the private institution (Sanjeevani hospital) the training status of their staff is not known. Transport and proper disposal of solid waste facilities are not up to the mark even in government institutions. Recently, the state government of Uttar Pradesh has made a contract with an agency for transportation and disposal of the solid waste generated from health institutions of government sectors. For liquid wastes there is neither proper record about quantity of waste generated nor for their discharging measures. It is directly discharged in sewer system in almost all institutions.

There is no attempt to minimize the quantity of waste generation; neither there is any attempt to switch over from more toxic to less toxic substances in respect of their use. Attempts are not being made regarding search or innovation of alternative article, equipments or liquids which are in use and are highly toxic like that of mercury, ethylene oxide, poly vinyl chloride etc.

Thus, it is clear that no efficient management of hospital waste is in existence. Rules in the form of Acts are also inadequate and lack of commitment to implement these Acts is common. Therefore, not only the private institutions, even the government health institutions are not interested in proper management and disposal of their wastes in accordance to the environmental rules.

References

Acharya DB, Singh M, 2000. The book of Hospital Waste Management. Minerva Press, New Delhi.

Dwivedi AK, Pandey S, Shashi, 2008. Hospital Waste. Indian Science Cruiser, 22(2): 10-14.

Dwivedi AK, Pandey S, Shashi, 2009. Hospital Waste: At a Glance. In Microbes Applications and Effect, Ed., P.C. Trivedi: Aavishkar Publishers and Distributors, Jaipur, India: 114-119 (ISBN 978-81-7910-271-8).

Dwivedi, AK, Shashi, Singh J, 2006. Water pollution and groundwater recharging. Current Science, 91(4): 407-408 (www.ias.ac.in/currsci).

Singh IB, Sharma RK, 1996. Hospital Waste Disposal System and Technology. Journal of Academy of Hospital Administration, 8 (2): 44-8.