



BIOMEDICAL WASTE MANAGEMENT PRACTICES AT KING GEORGE'S MEDICAL UNIVERSITY, LUCKNOW, UTTAR PRADESH, INDIA - A 3000-BED TERTIARY CARE HOSPITAL

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ABSTRACT

Biomedical Waste Management (BMWM) is an integral part of infection control and hygiene programs in healthcare settings. Biomedical waste poses serious threats to environmental health and requires specific treatment and management prior to its final disposal. This study investigated the status of BMWM practices (segregation, collection, transportation, storage and final disposal) and quantification of wastes generated in King George's Medical University (KGMU), a 100 year-old, tertiary care institute in Lucknow, North India. The results of this study revealed that biomedical waste is segregated at the point of generation, which reduces the quantity of incinerable waste. Infectious waste generated in the hospital is about 19-20% of total waste generated of which only 4-5% waste is disposed off by incineration. The remaining percentage of infectious wastes (plastic, glass and sharps) is first treated in the hospital waste treatment facility. All infectious plastic waste is treated by autoclaving to make them noninfectious, than shredded into small pieces and

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finally sent to an authorized recycler. KGMU establishes a foolproof BMWM setup that ensures its proper collection, transportation, storage and disposal as per norms.

Keywords: Biomedical waste management, incinerable waste, recyclable waste, segregation, disposal

1. INTRODUCTION

Improper management of biomedical wastes from hospitals, clinics, and other health facilities poses occupational and public health risks to patients, health workers, waste handlers, haulers, and communities. Infection poses risks by direct contact with sick people, needles and medical equipment punctures, thus conveying blood-transmitted diseases and the ingress of outdoor pollutants make management of hospital environment a necessity (Figure 1).

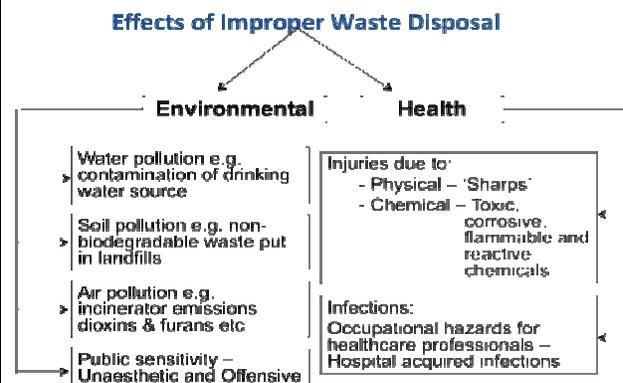


Figure 1 Effect of improper waste disposal

The ultimate objective of biomedical waste management is to prevent the transmission of infections to healthcare personnel, patients, attendants and the community at large. Proper handling and disposal of biomedical waste entails the sequential steps of handling, segregation at point of generation, storage, disinfection, mutilation, transportation and disposal. Worldwide, the waste management function is dealing with a considerable rise in environmental and legal standards, best practices, occupational health and safety, quality management, and the need for increased efficiency.

The World Health Organization [1], US Environmental Protection Agency [2,3], US Centers for Disease Control and Prevention [4], Italy [5] and Germany [6,7] have already established stringent guidelines for the management of biomedical waste.

The Government of India felt the need to regulate

biomedical waste generated in healthcare facilities throughout India and hence ratified the biomedical Waste (Management and Handling) Rules on 20th July 1998 [8]. Subsequent amendments were introduced in 2000 and 2003. The health sector's mandate is to prevent and cure disease.

Despite a formal law being introduced in 1998, BMW has not been given adequate emphasis by health care facilities in India and other developing nations. The increasing patient turnover, use of disposables and indiscriminate use of antibiotics has further compounded the problem. Yet the delivery of health care services often inadvertently contributes to the problem. Hospitals generate significant environmental health impacts through the natural resources and products they consume as well as through the waste they generate.

In the present study we assess existing hospital waste management practices (e.g. available procedures, techniques, methods of handling and final disposal) and determine the quantity of infectious and non-infectious waste generated.

2. MATERIALS AND METHODS

Lucknow is situated on 26.30 and 27.10 north latitude and 80.30 and 81.13 east longitude. Lucknow covers an area of 2528 square km and the river Gomti flows through the city. The population of district Lucknow as per census 2011 is 4,588,455. Lucknow is well connected by rail, road and air to Delhi, Patna, Calcutta, Bombay, Varanasi and Nepal.

The King George Medical University (KGMU) is situated in the heart of Lucknow, which is the capital of Uttar Pradesh India's most populous state. The institution is committed to the dissemination and advancement of knowledge in biomedical sciences and establishing itself as a centre of excellence in tertiary level health care in the state. KGMU has a hospital complex spread over an area of 88,000 m² with a conglomeration of buildings housing various departments and their respective wards. The hospital has various dedicated in-patient and outpatient departments and a separate building for surgical emergency and trauma patients. The total numbers of registered beds are 3000, with a bed occupancy rate of 90-100%. The annual outpatient attendance is about 510,000 and the indoor admissions number about 51,000 year⁻¹. KGMU has over 44 departments and provides a range of medical facilities to its patients ranging from histopathology, cytology, hematology, biochemistry, serology, microbiology, radiology including ultrasound and computer to-

graphy, cardiac catheterisation, pacemaker implantation, balloon arterial angioplasty, Holter monitoring, electroencephalography, nerve conduction velocity, electromyogram, evoked responses, audiometry, electroretinogram, hemodialysis, endoscopy, bronchoscopy, open heart surgery and hormonal assays to name a few. Neonatal intensive care facilities are available, as are medical intensive care and intensive coronary care facilities.

The study was conducted through surveys and interviews with the BMW committee members, nurses, BMW staff, sweepers and personnel involved in the collection, transportation and disposal processes. Observation techniques were also used to verify the authenticity of the information given by the respondents. Waste generation data were obtained from waste management system records. Six month (January to June, 2012) waste generation data are presented with the percentage of infectious and non-infectious waste.

3. BIOMEDICAL WASTE MANAGEMENT COMMITTEE

The KGMU Biomedical Waste Management (BMW) Committee was constituted in the year 2009. The Committee consists of the Head of the Institution, Chief Medical Superintendent, Financial Officer (FO), Registrar, Matron, Civil Engineer, Sanitary Inspectors, Heads of some clinical departments and a Member Secretary, who is the key person responsible for all the activities related to BMW. To coordinate BMW activities in the various departments of the University, a faculty member from each department was appointed as Nodal Officer (NO). The Nodal Officer was made responsible for each and every activity related to BMW in their department. The Nodal Officers were advised to implement the BMW practices as per the norms and hospital policy.

4. RESULTS

4.1. Status of Biomedical Waste Management Practices

4.1.1. Segregation

The wastes are segregated according to their characteristics at the point of generation. The medical university uses high-density polyethylene bags within the color-coded bins that bear specific workstation codes for easy

identification and good segregation practice. Infectious wastes are collected in yellow, red, white and blue color-coded bins labeled with a biohazard symbol, while non-infectious waste is collected in black bins without a biohazard symbol. Used syringes are mutilated at the point of generation with the help of a hub cutter that minimizes the re-use of syringes. Posters are pasted on the walls near to the bins describing which type of waste should be disposed in which bin. The posters are in local language with pictorial depiction so that everybody can understand. To facilitate waste segregation at the point of generation, there are two types of trolley provided in each ward: Procedure and Nursing trolleys with small bins of different colors mounted on them. The details of the segregation of the waste in the containers are shown in Table 1.

4.1.2. Collection Process and Time Duration

The collection of infectious and non-infectious wastes is undertaken by seven teams of four members each, one track-in-charge (to supervise the condition and cleanliness of infrastructure provided), one supervisor (to supervise the waste collection process and record waste weight) and two sweepers (for pulling the trolley, sealing the bags, weighing the bags, placing empty polyethylene bags in the bins, putting the bags onto the trolley). Generally waste is collected twice a day but in some departments waste is collected 3 or 4 times in a day depending on the waste generation rate. The wastes are collected by trolley. The staff employed for handling hospital waste use personal protective gear that includes

mask, gloves, apron and boots, and are fully vaccinated for tetanus and hepatitis B.

4.1.3. Transportation

In the transportation process 3 types of trolley are used in the KGMU. Small (for narrow space) and large ward collection trolleys are used for waste collection within the wards of the same department. Rickshaw trolleys are used for transportation of waste from wards to the storage site. Trolleys used for waste collection and transportation are leak-proof, covered and bear a biohazard symbol. Waste collection and transportation trolleys are washed with disinfectant solution after each shift.

4.1.4. Central Collection and Treatment Site (CCTS): the Storage Area

A site situated in a comparatively secluded area in the hospital surrounded by greenery was selected as storage area. The central collection and treatment site is appropriately ventilated with fire protection facilities and fitted CCTV cameras. In the CCTS, infectious and non-infectious wastes are stored in separate rooms. Sharp waste coming from different tracks is transferred to a metal box at the storage site. The waste storage period in CCTS is 24 hr. The working staff of CCTS uses personal protective gear including mask, gloves, apron and boots and all are fully vaccinated for hepatitis B. Two autoclaves, two plastic shredders and one paper shredder are installed in the CCTS (Figure 2).

Table 1 Categories of waste generated in KGMU

SN ^a	Category	Items	Color Coding
1	General waste	Paper, wrappers, peels of fruits and vegetables, remains of food and edibles, etc.	Black
2	Non-Plastic Infectious Waste	Human and animal anatomical waste, waste contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines beddings, other material contaminated with blood	Yellow
3	Plastic Infectious Waste	Disposable items such as glucose bottle, hub removed syringe tubing, catheters, intravenous sets, gloves etc.)	Red
4	Sharp Waste	Needles, scalpels, blades, etc. that may cause punctures and cuts. This includes both used and unused sharps, etc	Puncture proof Red Container
5	Glass Waste	Glass materials like bottles, ampoules, slides, tubes, etc	White
6	Liquid Waste	Waste generated from laboratories, washing, cleaning, housekeeping and disinfection activities, chemicals used in production of biological, chemicals used in disinfection, as insecticides etc.	Blue

^aSN=segregation number

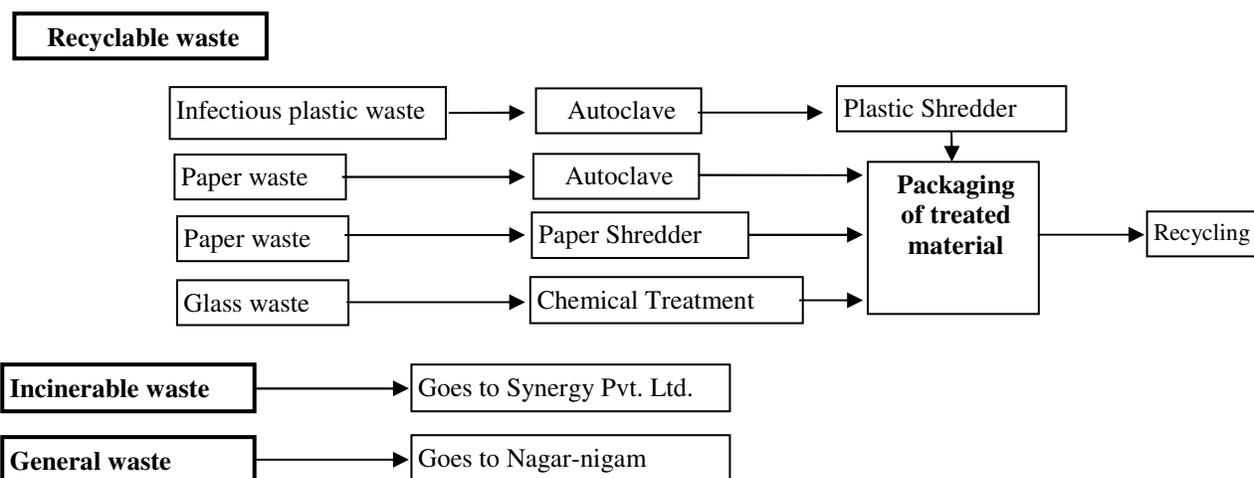


Figure 2 Flow of work in central collection and treatment site (CCTS)

Table 2 Process of treatment and disposal at KGMU

SN ^a	Type of Waste	Treatment and Disposal Process used at KGMU
1	General waste	Goes to Nagar-Nigam for land filling.
2	Incinerable waste	Goes to Synergy Pvt. Limited (Central Treatment Facility) for incineration.
3	Infectious plastic waste	Autoclave → Segregation → Shredding → Sold for recycling
4	Sharp	Autoclave → Recycling by authorized recycler
5	Glass	First treat with chemical (2% hypochlorite solution) for ½ hrs and sold.
6	Paper	Shredding → Recycling
7	Linen	Autoclave → Recycling

^aSN=segregation number

Table 3 Summary of waste quantity from January to June 2012

Month	Non-infectious waste(kg)	Infectious Waste (kg)				Total waste (kg)	%	
		Yellow waste	Red waste	Sharp waste	Glass waste		Non infectious waste	Infectious waste
January	58675.5	3505.08	10066.9	151.41	2256.75	74655.64	78.59	21.41
February	58314.2	2510.3	7453.8	173.71	1963.9	70415.91	82.81	17.19
March	60618.8	3238.4	8025.5	153.04	2088.5	74124.24	81.78	18.22
April	56877.9	3599	7592.55	167.23	2151.8	70388.48	80.81	19.19
May	69415.1	3338.5	11006.45	174.62	2728.5	86663.17	80.1	19.9
June	69990.1	3250	9593.9	165.56	2686.1	85685.66	81.68	18.32
Average	62315.26	3240.21 (4.2%)	8956.51 (11.63%)	164.26 (0.21%)	2312.59 (3%)	76988.85	80.96%	19.04%

4.1.5. Treatment and Final Disposal:

In the KGMU, except for infectious non-plastic and general waste, all types of waste are treated and disposed off at the Central Collection and Treatment Site. Infectious plastic waste is first autoclaved without the bags being opened; treated bag materials are segregated into different categories (gloves, glucose bottle, hub removed syringes, tubing and so on) on the sorting table. Treated segregated waste is shredded into small pieces. The sharp wastes metal box is also kept in the autoclave along with waste bags for sterilization. Glass waste is treated with 2% hypochlorite solution at the site. Treated infectious plastic, sharp and glass wastes are packed at the storage site and sent to authorized recyclers for recycling. Infectious non-plastic waste goes to the Central Treatment Facility (Synergy Pvt. Ltd.) for incineration and general waste goes to Municipality Corporation for landfills. All confidential and non-confidential paper waste is shredded in the presence of a responsible person and sent to authorize recyclers for recycling. Details of treatment and disposal process are given in Table 2.

4.2. Quantitative Determination of Biomedical Waste

The amount of biomedical waste depends upon various factors such as the type of healthcare facility, number of beds, segregation of biomedical wastes at the point of generation, and medical activities.

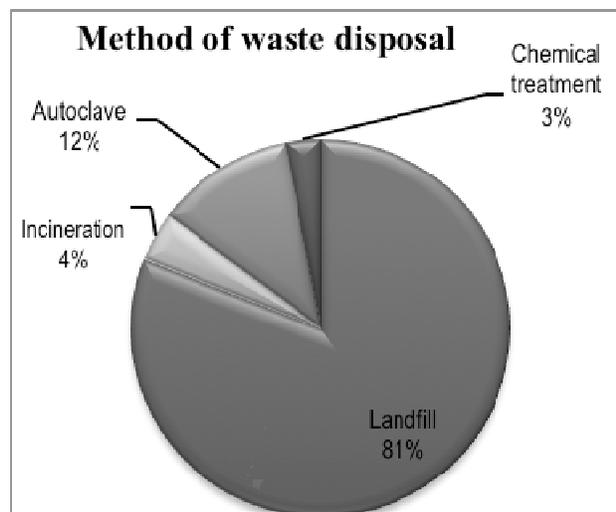


Figure 3 Percentage of waste treated by different technology

Table 3 presents the quantity and compositions of biomedical waste produced by KGMU based on a survey conducted during the study period. It is apparent that the average daily waste generation rate is 2566.3 kg. The total waste generation rate in KGMU was 76988.85 kg/month, which includes 62315.26 kg (80.96 %) of non-infectious waste and 14673.57 kg (19.04%) infectious waste among which the amount of infectious non-plastic waste, infectious plastic waste, sharp waste and glass waste was 3240.21, 8956.51, 164.26 and 2312.59 kg, respectively. KGMU goes for an annual contract with the Central Treatment Facility for terminal disposal of infectious non-plastic waste (Figure 3).

4.3. Training and Monitoring

The implementation of good biomedical waste management practices in the hospital needs not only thorough knowledge but also proper attitude and practice by healthcare personnel. Regular training programs are conducted in KGMU for the healthcare personnel to change their attitude, which leads to good biomedical waste management practices. Three types of training programs are conducted in the institute. First is Departmental Training (in which various categories of healthcare personnel of the same department are involved). Second is New Entries Training (in which all new entry healthcare personnel are involved) and Third On Demand Training. Rounds, which are taken very enthusiastically by the Nodal officers/ BMW team from time to time/regularly to look for fallacies in the infrastructure and apply corrective measures immediately to ensure successful implementation of the program.

5. DISCUSSION

At KGMU biomedical waste management was initiated under the GEF/UNDP-MoEF Project in August 2010. Under this project a well-developed Biomedical Waste Management System (BMWM System) was established. Before this project the situation of biomedical waste management practices were same as in other hospitals. Waste segregation was almost absent at all workstations. Mixed waste from all containers was being handed over to the collection agency [9]. Proper biomedical waste management will reduce the environmental and health impact of the healthcare industry. Further, as evidenced by the results of our study in KGMU, segregation of waste at the point of generation and further segregation of autoclaved plastic waste helps in reducing the quantity of incinerable waste and helps reducing the

production of dioxins since plastics are not inadvertently sent for incineration.

Segregation is the first and crucial step of BMWW practices that determines the quantity of infectious and non-infectious waste. According to WHO, infectious waste comprises 10-15% and non-infectious waste 85-90% of the total waste stream. The American Hospital Association points out that the quantity of infectious waste should not be more than 15% of the total waste stream and a number of United States hospitals have implemented good segregation programs that reduce the infectious waste quantity to less than 6% [10]. In

KGMU, the average amount of infectious waste is 19% of which only incinerable waste (human and animal anatomical waste, waste contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, linen beddings, other material contaminated with blood) goes to the incinerator. This constitutes about 4.2% of the total waste generated. The fraction of infectious waste is treated at the storage site and is sent for recycling. This constitutes about 14.8% of the total waste generated. The status of BMWW practices at most other hospitals is poor and inadequate and thus not conforming to standards laid down by law.

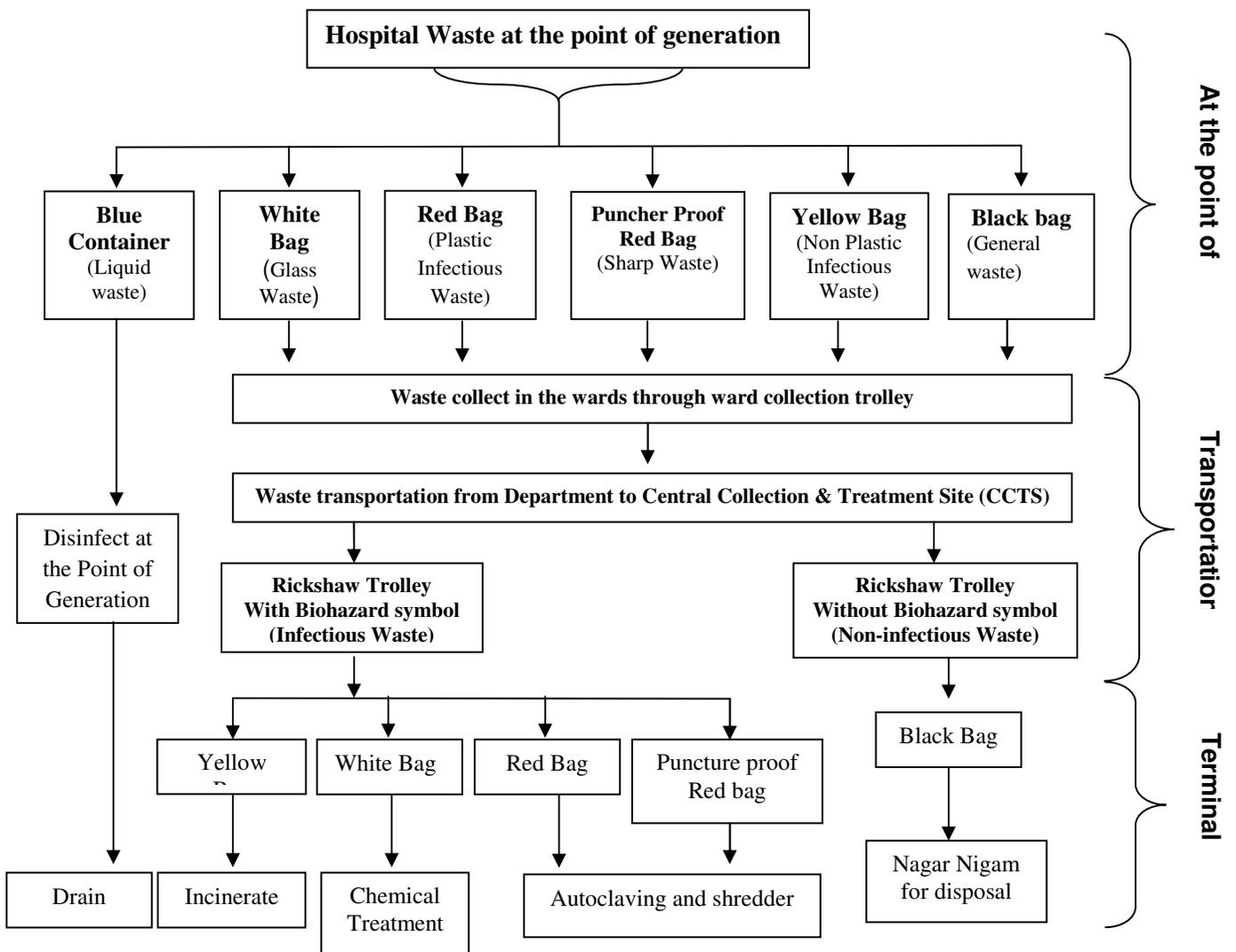


Figure 4 Flowchart of biomedical waste management practices in King George Medical University

In 2002, the results of a World Health Organization assessment conducted in 22 developing countries revealed that the percentage of health care facilities that do not follow proper waste disposal methods ranges from 18% to 64% [11]. A survey conducted by Shinee et al. [12] in 56 health care facilities of Ulaanbaatar found that healthcare waste was not properly managed (segregate, collection and disposal). About 2.65 tonnes of healthcare waste is produced every day in Ulaanbaatar city among which the infectious waste ranges from 12.5% to 69.3% depending on the type of health care facility. The biomedical waste management system needs improvement at every stage of waste handling i.e. segregation, collection, treatment and disposal. Troubles were mainly observed because of the lack of adequate staff training on biomedical waste management issues and on the hazards that might come out from their improper handling. In KGMU regular training programs are conducted to improve the knowledge of healthcare personnel and management practices regarding biomedical waste. In Chennai a study was conducted by Radha *et al.* [13] in different health care settings. The results showed that the biomedical waste management practices were not satisfactory. Waste were not segregated according to the color coding, Storage of waste was not in an isolated area, protective equipment and accessories were not regularly provided and most of the hospitals do not have proper waste treatment and disposal facilities. A study conducted by Abhimanyu Singh *et al.* [14] in the 5 hospitals of Jhansi found that most of the private as well as Government hospitals do not properly implement best biomedical wastes management practices as per the BMW 1998 rules. The biomedical waste management system of King George's Medical University can be a role model for the other hospitals of Lucknow and of India (Figure 4).

6. CONCLUSION

This study concludes that biomedical waste management practices at KGMU are complying with standard legal norms and procedures as per the Biomedical Waste Management Rules 1998. Hospital waste is segregated at the point of generation according to color-coding. Waste collection, transportation, storage and disposal are done as per the norms. Except infectious non-plastic and non infectious (general) waste, all other categories of waste is treated and disposed of in a central collection and treatment site. Records are kept of waste weight, autoclave cycles, paper shredded and plastic shredded. All paper waste generated in the university is shredded into small pieces and sent to an authorized recycler.

Regular training and monitoring is done by the members of biomedical waste management committee. Personal protective equipment and accessories are provided and rigorously used by waste handlers. The University has also been made a center for a six-month Certificate course of Health Care Waste Management (CHCWM).

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