

## Management of Bio-Medical Waste in Himachal Pradesh: A Case Study of Indira Gandhi Medical College and Hospital, Shimla, HP, India

Ravinder ST<sup>1,2\*</sup>

<sup>1</sup>Department of Animal Husbandry, Himachal Pradesh, India

<sup>2</sup>BVSc and A.H., MPH, University of Liverpool, UK

\*Corresponding author: Ravinder ST, Department of Animal Husbandry, Himachal Pradesh, India, Tel: (0177) 2804251; E-mail: [ravinder.thakur2010a@gmail.com](mailto:ravinder.thakur2010a@gmail.com)

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### Abstract

This paper is a qualitative case study about the biomedical waste management practices being followed in a leading healthcare institution in North India. An exploratory qualitative study using purposive sampling was conducted among health professionals and waste handlers of Indira Gandhi Medical College, Shimla. 60 participants were selected for questionnaire based inquiry and 4 semi-structured in-depth interviews were conducted to gather data on daily average production and compliance of waste management rules 2016 in the healthcare facility. Thematic content analysis and chi-square methods were used to process the data. The findings suggested that the institution on an average is producing 40 kg to 65 kg of biomedical waste daily. Chi-square analysis showed that awareness about the biomedical waste management rules 2016 significantly affect the quality of biomedical waste management. The study identified potential gaps in handling, segregation, and transport of different types of wastes. Carelessness at point of segregation, lack of periodic training and insufficient allocation of resources were the major critical gaps concluded by the study. However, the study holds the limited transferability due to qualitative design and purposive sampling.

**Keywords:** *Biomedical waste; Biomedical waste management rules 2016; Health professionals; Handlers; Qualitative design; Chi-square analysis*

### Introduction

All human activities result in generation of some kind of waste which may be categorised as municipal, industrial, sewage, agricultural and hospital waste. These wastes can pollute water, soil, air and thus should be handled carefully [1]. According to World Health Organization 85% of the waste generated is non-hazardous. 10% of the waste is infectious and remaining 5% is non-infectious but considered as hazardous wastes [2]. In United States of America about 15% of the wastes are regulated as infectious waste while in India this may go up to 15% to 35% depending upon the production of waste [3]. According to Biomedical Waste Management Rules 2016 biomedical waste may be defined as “any waste that is generated during the diagnosis, treatment or immunization of human beings or animals in the health care institutions or outdoor” [2]. In

addition to this biomedical waste is also generated during the research activities, testing of drugs and other biological material like cosmetics [4]. The World Health Organization has categorized the biomedical waste into eight different categories depending upon the nature of generation and the risks of causing injury during the collection, handling, and disposal of the waste [5]. These include general waste, pathological waste, radioactive waste, chemical waste, infectious and potentially infectious waste, sharps, pharmaceuticals and pressurized containers. Among the different kind of wastes generated some need greater attention and precautions while handling. These may include sharps (needles, scalpel blades etc.), pathological and microbiological wastes (blood samples, body tissues organs, microbiological cultures etc.) and other infectious wastes (contaminated syringes, catheters, IV set, etc.). Besides this some environmentally sensitive by-products like radioactive wastes, mercury instruments and plastic materials (syringes, bottles, packaging material etc.) are the other kind of wastes generated in the health care institutions [6]. Biomedical waste management ensures proper hygiene in the health institution and safety of healthcare workers and communities [7].

The medical waste management processes include handling, segregation, mutilation, disinfection, storage, transportation, and final disposal [1]. The government of India has specified that hospital waste management is a part of hospital hygiene and maintenance activity. India enforced Biomedical Waste (Management and Handling) Rules, 1998 for safe collection, segregation, transport, and disposal of biomedical waste in the country. These rules have undergone latest revision and modifications recently. Now these rules have been renamed as Biomedical Waste Management Rules 2016 that have come in to the existence since March 2016.

The wide variety of activities at healthcare facilities generates different types of waste and there is always a danger of spreading infection due to mishandling of infectious waste or sharps [8]. However, it seems that the fraction of waste generated at healthcare institutions has not attracted the same level of attention as other types of wastes, despite its serious health implications [2,9].

## **Case Presentation**

### **Aim**

This paper is a qualitative case study to explore the factors influencing the biomedical waste management practices and perspectives of waste handling staff in a leading healthcare Institution Indira Gandhi Medical College, Shimla in Himachal Pradesh, India.

## **Methods**

### **Design**

The purpose of this study was to identify the underlying factors responsible for current biomedical waste management practices being carried out in Indira Gandhi Medical College and hospital, Shimla in HP India. The study also explored the perceptions of healthcare professionals and handlers about the biomedical waste management rules from “etic” or outsider perspective. The study used the exploratory qualitative study design and mixed analytic approach [10]. The study tested the null hypothesis that the compliance of biomedical waste handling and management rules 2016 and level of awareness about these rules do not affect the quality of biomedical waste management practices significantly in Indira Gandhi Medical College and hospital, Shimla in HP, India.

### **Setting**

The study was carried out in Indira Gandhi medical college, a leading medical college and hospital of the state Himachal Pradesh in India. This institution came in to existence in 1966 and presently has 33 different specialized departments and attached 872 bedded hospitals. This is one of the modern and prestigious medical institutions in the country. The institution is engaged in providing specialized medical services to patients, teaching and research activities. Due to heavy inflow of indoor and outdoor patients the institution generates different categories of biomedical waste. The biomedical waste management in the institution is carried out as per biomedical waste handling and management rules 2016.

### **Sampling**

A purposive sampling method was used to select 64 information rich participants. These included 60 participants for questionnaire based information and four key informants for in-depth semi-structured interviews. The sixty participants included 20 doctors, 20 nursing staff members and 20 waste handlers. Initially 2 participants were recruited from each group and using snowball sampling method, personal acquaintances of these initial recruits were used to select the remaining sample size in each group. For in-depth interviews four informants were selected purposively which have supervisory and coordinating roles in management of biomedical waste management of the institution.

### **Data collection instrument**

Modified semi-structured survey questionnaire was used to collect data from the respondents [11]. The questionnaire included both closed and open-ended questions about the biomedical waste management procedures, level of awareness and improvements required in waste handling. Some of the questions were dichotomous recording the feedback like whether you are directly or indirectly involved in the waste management. The questions about the quantity of waste generated daily were ordinal, polytomous. The interviews were aimed at collecting the perspectives of key persons involved in supervision of biomedical waste management using semi-structured interview guide. The interview guide included open ended questions on the management practices regarding bio-medical waste management being followed in the institution. Each interview lasted for about half an hour and included about 15 questions. Some data was also collected using the technique of participant observation. The site of central waste collection and processing unit was also visited and data was collected on the process and procedures followed by the identified stakeholders.

### **Ethics**

Written and signed informed consent was obtained from each participant before start of the study [12]. The participants were conveyed about the basic purpose of study and the role they would play in the study. They were explained the voluntary nature of the study and their free will to leave the survey any time. The participants were given assurance that the information given by them will be kept confidential.

All the participants were apprised that their identities will not be revealed at any stage and information given by them will not be related back to them. The permission from the gatekeeper was taken to gain access to the institution for data collection. The Deputy Medical Superintendents of Indira Gandhi Medical College and Hospital, Shimla was approached for permission to gain access to the institution.

### **Validity and rigour**

The data collection process was carefully planned to ensure. Credibility of the study was increased by building rapport with the study participants and simultaneously using triangulation method of data collection. Each step of the research study was carefully noted by making thick description. This increased the transferability of the study. As researcher, I tried to maintain ethical neutrality by making use of reflexive journal and bracketing [13]. The questionnaire used for collection of data was WHO standardized questionnaire. Some of the questions were modified keeping in view the nature of study, type of institution and kind of participants. For example, a simpler and easier modified version in Hindi language was prepared for the waste handlers who do not had good hand in English language. The questionnaire was pilot tested on four respondents before carrying out the actual study to gather feedback on the receptivity and understanding of the questions. Standardized interview guide was used for in-depth interviews.

### **Data collection**

Data collection was done during the months October to December 2016 in the campus of Indira Gandhi Medical College and Hospital, Shimla. Written informed consent from each of the participants was obtained before data collection. The in-depth interviews were arranged for four identified key informants i.e. Deputy Medical Superintendents, Hospital Administrator, Nodal officer of biomedical waste management of the institution and in charge of common waste collection unit. The interviews were arranged in the rooms of the informants by seeking prior appointments. Interview guide consisting of about 15 open-ended questions was prepared for the interview. The raw data was recorded by making rough notes. Interviews were transcribed and coded. Modified semi-structured questionnaires were circulated among 60 participants from three different categories. In the first phase 20 doctors from different clinical and para-clinical departments were approached for the participation. In second phase 20 participants from the Para-medical fraternity were chosen for the study. Lastly 20 participants from among the waste handlers were selected for the study. For them the modified standardized questionnaires were further simplified and translated to Hindi language to overcome the barrier of language. All the participants completed the questionnaires and signed the informed consent section. Two sites were chosen for the participant observation. Firstly, the two clinical departments and two paraclinical departments were visited in the morning hours and whole process of data handling, segregation, packaging, and transport was recorded. Some photographic evidence was also collected. The central processing unit of the institution was also visited to observe how this unit take care of biomedical waste being received from the different departments of the medical institution. Written and photographic evidence was recorded at this site.

### **Data analysis**

Data analysis was carried out by applying mixed analytic methods. Thematic content analysis and constant comparative technique were used to draw inferences from the transcribed and coded textual data [14]. Themes and subthemes were derived from transcribed coded textual data [15,16]. Analytic methods were used process the numeric data collected through questionnaires. First processing tool used to the questionnaire data was the data validation. Through data validation the questions not answered by majority of participants were excluded. The next processing tool applied was the response partitioning. By this the responses recorded from three different groups of informants were divided into subgroups. Data coding was done for the nominal and ordinal data. The coded numeric data was processed using statistical application manually as well as using statistical software Epi Info 7. Digital photographic data was suitably processed, captioned and used to support the finding as depicted by descriptive and numeric data. For assessment of the level of awareness chi-square

was applied to numeric data collected. Chi-square is a statistical measure used in the context of sampling analysis for comparing a variance to a theoretical variance. As a non-parametric test, it can be used to determine if categorical data shows dependency or the two classifications are independent. It can also be used to make comparisons between theoretical populations and actual data when categories are used. Five categories of awareness which included awareness of general practices, safety practices, reports, resource allocation and quality control were concluded in tabular form. There was the observed negative response and observed positive response.

## Results

### Basic demographics of the participants

The data revealed that out of 64 respondents, 28% were male and 72% were female. Females were significantly higher than males participating in the study. The data on the professional composition of the study respondent showed that 36% of the participants were doctors, 33% were nurses and rest 31% were waste handlers. The finding showed that out of total 64 respondents 36% were post graduate mostly the medical doctors from different discipline 33% of respondents were graduate. These were the paramedical staff members. The remaining 31% belonged to undergraduate category. This population was represented by waste handlers.

### Approximate average daily generation of biomedical waste in the health institution

Different departments of the hospital and college generate bio-medical waste in different ranges. Wards and OPDs contribute more waste followed by the laboratories and teaching departments. The average daily generation of the bio-medical waste in Indira Gandhi Medical College ranges from 40 Kg to 65 Kg daily as shown in the TABLE 1 below:

TABLE 1. Average daily generation of biomedical waste.

S.N.	Waste generation section	Approximate average per day generation of biomedical waste
1.	Wards	20 kg – 35 kg
2.	OPDs	15 kg – 20 kg
3.	Laboratories	3 kg – 5 kg
4.	Teaching and research	2 kg – 5 kg
	Total per day average	40 kg – 65 kg

### Types of biomedical wastes in Indira Gandhi Medical College and Hospital, Shimla

The different types of waste generated during the routine treatment and teaching practices of the institution was categorised as per the schedule described according the Biomedical Waste Handling and Management Rules 2016. The waste categories included: general, pathological, infectious, radioactive, pharmaceutical, chemical sharps and pressurized. The general wastes were found in all departments in different forms and were segregated in black bins and liners. Sharp wastes were segregated in sharp boxes in all departments.

### **Management of general wastes**

General waste from the hospital consists of: organic waste-mostly food remains and kitchen related by-products, paper waste, plastic waste, bottles. Every department from the hospital generates general waste which is mostly gathered in a green or black bin and lining, and when the bin is full the housekeeping personnel in charge collects the waste to be put in black polythene bags. From their these black bins are transported to the central waste collection unit from where the city municipal vehicle collects this waste and carries this to the centralised waste treatment plant on daily basis.

### **Management of solid and chemical waste in yellow bins**

The waste which includes human anatomical waste, animal anatomical waste, expired medicines, chemical waste, liquid waste, discarded linen, microbiological, biotechnology waste, and cytotoxic drugs are being collected in the yellow coloured non-chlorinated plastic bags or containers and transported to the central collection unit. The central collection unit transports this waste further to the incinerator.

### **Management of sharps and glassware**

As per revised guidelines the sharps which include metals, needles, fix needle syringes, scalpels, blades etc., are collected in white translucent containers. These are puncture proof and leak proof. These containers are transported to central collection unit for further treatment and transport to incinerator. The other sharps like glassware, broken or discarded glass and metallic implants are collected in cardboard boxes bearing blue coloured markings. These are then further transported to the central collection unit.

### **Management of plastic material**

Indira Gandhi Medical College and hospital uses red coloured non-chlorinated plastic bags and bins for the collection of recyclable plastic materials, I/V sets, urine bags, syringes, vacutainers etc. The plastic material after collection is sent to the central processing unit for autoclaving and shredding. After this the material is transported to the incinerator for final disposal.

### **Transportation of waste containers**

The hospital has provided wheeled trolleys and carts for transporting wastes within the facility. But only few trolleys are available and most of the containers are transported manually to the central collection unit of the institution.

### **Awareness about the biomedical waste management rules 2016**

Majority of the respondents stated that they are aware of the new rules of bio-medical waste management known as Bio-Medical Waste Management Rules 2016 which has come into practice in the institution since March 2016. Out of 64 participants who participated in the study, 48% were directly involved in the handling of the bio-medical waste while 52% were supervising the work of waste management.

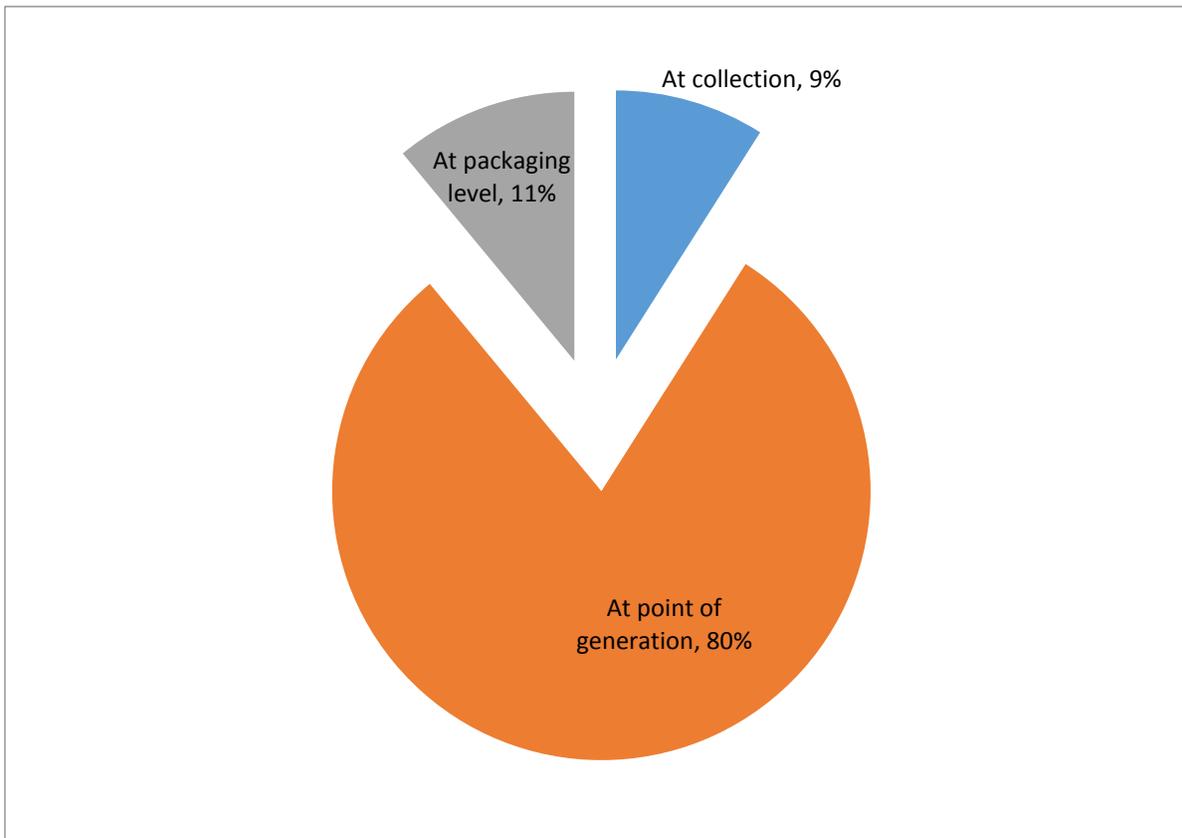
### **Use of protective and safety measures while handling biomedical waste**

The participants showed difference in the extent of safety measures used during the handling and management of the bio-medical waste. 22% of the respondents use only gloves while handling the waste. Another 31% of the respondents make use

of gloves and masks. Only remaining 47% of the respondents make use of gloves, masks and aprons while handling and managing the bio-medical waste. Since using chi-square analysis (TABLE 1) calculated value is greater than the table value so null hypothesis is rejected. So, this can be concluded that the awareness about the safety measures of bio-medical waste handling affect the use of safety measures by the respondents.

**Awareness about the point of categorical segregation of biomedical waste**

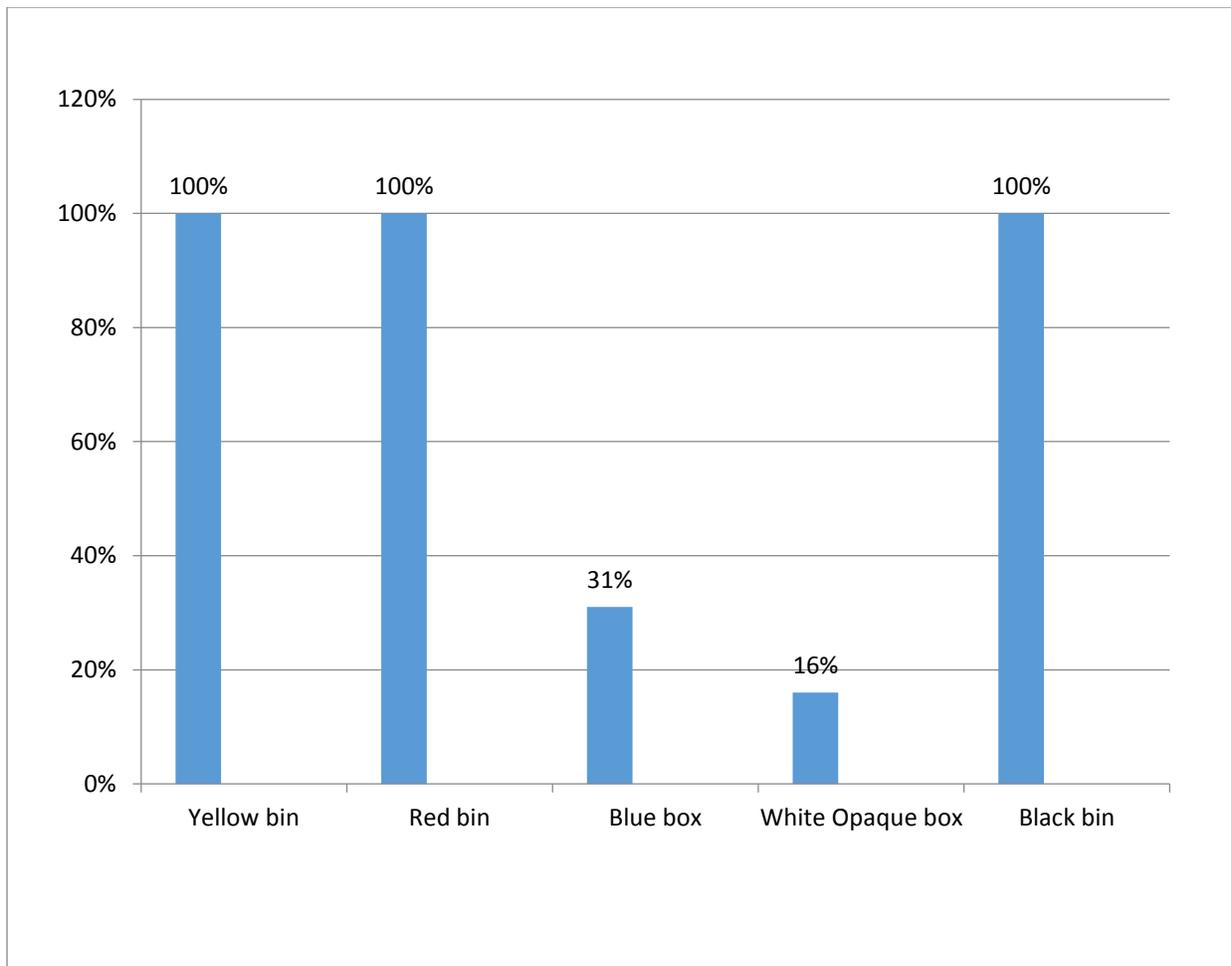
About 80% of the respondents revealed that the segregation of bio-medical waste is done at the point of generation. Only 9% thought that segregation should be done at the point of collection while 11% of the respondents revealed that segregation can be done at the point of packaging (CHART A).



**CHART A. Showing the level of awareness about segregation point.**

**Awareness about the colour coded dustbins**

100% of the participants showed the understanding and knowledge about the yellow, red, and black bins being used for the management of bio-medical waste management in the institution. However only few were aware about the newly introduced white opaque and blue boxes. 18% showed awareness about the white opaque containers while 37% of the respondents knew about the blue card boxes. The varied level of awareness about the bins is shown in the CHART B below:



**CHART B. The level of awareness about colour coded bins.**

**Handling of sharps**

The sharps are handled following two steps. First step is burning and breaking. Then the broken sharps are treated with chemical (sodium hypo chloride) and then packed for further disposal. 92% of the respondents were aware of both the steps of sharp handling. They were following the practice of destruction and chemical treatment of sharps before packaging and transport to the central collection unit. Only 8% of the respondent were following the first step only and bypassing the chemical treatment of the sharps.

**Chi-square test**

In the table, there are five categories of awareness which include awareness of general practices, safety practices, reports, resource allocation and quality control. There is the observed negative response and observed positive response. The calculations are shown in the TABLE 2 as below:

TABLE 2. Table showing chi-square values.

Awareness category	Negative response			Positive response			Total
	Observed (O)	Expected (E)	(O-E) <sup>2</sup> /E	Observed (O)	Expected (E)	(O-E) <sup>2</sup> /E	
General management	39	33	1.09	25	31	1.16	64
Safety measures	29	33	0.48	35	31	0.51	64
Record keeping and reports	22	33	3.67	42	31	3.90	64
Resource allocation	49	33	7.76	15	31	8.26	64
Quality control	25	33	1.94	39	31	2.06	64
	164		14.94	156		15.89	320

Sample size N=320

**Expected values:**

- Negative Response=(64) (164)/320=33
- Positive Response=(64) (156)/320=31

$$X^2 = \sum (O - E)^2 / E$$

**Positive response**  $X^2 = \sum (O - E)^2 / E = 15.89$

**Negative response**  $X^2 = \sum (O - E)^2 / E = 14.94$

Calculated Chi-square  $X^2=15.89+14.94=30.83$  Degree of freedom is=4. Critical value of chi-square using tables at 0.05 confidence level gives 9.49, i.e.  $X^2$  critical= $X^2$  0.05, 4=9.49.

Since chi-square calculated is greater than chi-square critical, so the  $H_0$  is rejected in which case the conclusion is that the biomedical waste management practices of Indira Gandhi Medical College, Shimla are significantly dependent upon the compliance of Waste Management Rules 2016 and awareness of staff members of the institution.

**Discussions**

The Indira Gandhi Medical College and hospital, Shimla faces a challenge of dealing with mixed wastes from different departments due to negligence by various waste handlers. Some waste handlers also mix the wastes despite the presence of the colour coded containers for the segregation of wastes in different departments. It was either due to lack of awareness by some staff members who had either not been trained in safe waste handling or had forgotten about the management practices.

Through all the departments except the administration and the public area, the different colour codes are used for the segregation of waste before transportation for final disposal. In the public area, there are metallic and plastic bins used for general wastes, even though sometimes things like diapers etc., are dropped in by patients after changing their babies. The colour coding practice is being followed by most departments at the hospital but few individuals are still found to be neglecting the use of colour codes (FIG. 1).



**FIG. 1. Colour coded bins and labelled cardboard boxes installed in casualty ward of hospital for collection of different types of bio-medical waste.**

61% of the respondents have felt that there is scope of improvement in overall management of bio-medical waste system of Indira Gandhi Medical College, Shimla. However, 39% of the respondents expressed satisfaction with the current level of management regarding biomedical waste. Regarding safety measures during biomedical waste handling and management 55% of the respondents felt that the safety measures were up to the mark while 45% of the respondents were of the opinion that this can further be improved. 66% of the respondents were satisfied with the level of record keeping of bio-medical waste management in Indira Gandhi Medical College, Shimla. However, 34% still felt that the record keeping regarding waste management needs improvement. 66% of the respondents felt the need for improvement while 34% were satisfied with the current level of resource allocation. 61% of the respondents felt that quality check of bio-medical waste management is done regularly by the authorities of Indira Gandhi Medical College, Shimla. However, 39% respondents expressed their opinion that quality check is not regular.

There is still a big problem of mixing of waste and the central collection unit of hospital ends up receiving the mixed waste that is not segregated which increases the cost of waste management. Even though the hospital has put in place different policies on health safety and biomedical waste management the percentage that represent the population that is not aware of the procedures due to lack of training or ignorance is high. The study has proposed following recommendations for improvement of the biomedical waste management of the Indira Gandhi Medical College and hospital, Shimla. The study has

indicated a need for training programs for different levels of hospital staff in biomedical waste management, mandatory staff training and education programs in waste segregation and strict monitoring of the current practices. Training programs on biomedical waste management for healthcare professionals need to focus on empowering them with sufficiently broad and practical knowledge. It is important to measure and quantify the amount of medical waste generated in each unit of the hospital periodically to ascertain which unit or department generates the highest and lowest amount of wastes. This may guide the resource allocation process of bio medical waste management [17].

The biomedical waste management plan should be availed to all departments with regular periodic inspections. A written biomedical waste management program must be included in a health care facility's policy and procedure manuals. It must also be included in the facility's in-house education, occupational health and safety, and orientation programs for all employees. This program must be regularly reviewed and updated by an appropriate review committee, which includes waste handlers as important stakeholders. Certain basic elements must be embodied in any biomedical waste management program to ensure that biomedical waste is handled and disposed safely and efficiently. Health care facilities must prepare contingency plans for dealing the issues like storage of refrigerated or frozen biomedical waste, excess waste, disposal facilities or equipment becoming inoperative, refrigeration or freezing facilities or equipment becoming inoperative and the disposal of biomedical waste if disposal services are disrupted. The effectiveness of waste disposal policies and procedures should be assessed regularly. The assessment process should be described in the policy and procedure manuals and should reflect the quality assurance requirements used in other areas of facility management. Waste should be collected daily (or as frequently as required) and transported to the central designated management site. Bags should be specified according to generation of the waste (e.g. general waste, bio-medical waste, organic waste etc.) The bags or containers should be replaced immediately with new ones of the same type. A supply of fresh collection bags or containers should be readily available at all the locations of waste production [18].

To be effective the extent of the program must be tailored to fit the size of the facility and the total amount of waste generated. Early involvement of the employees in the planning process and continuous staff training are the critical elements of successful medical waste minimization programs. Employees must be fully aware of the contents of the facility's waste management plan including regulations that apply, how to segregate the type of waste the facility generates, how to choose environmentally preferable materials and how to properly dispose of infectious and hazardous wastes. There also should be a feedback system such that a facility can direct, investigate, and correct deficiencies and problems [19].

## **Conclusion**

Indira Gandhi Medical College and Hospital is well managed and operates efficiently to meet the need of medical services to its patients under given resources. The hospital generates different categories of waste and to some extent manages these within acceptable standards. The wastes get segregated at source of production, and go through different stages of waste management prior to final disposal. It has also adhered to the latest revised Bio-Medical Waste Management Rules 2016. The staff awareness on different aspects of the hospital's practices with regard to waste handling, policies and environmental health safety and protection can be further improved. The key informants i.e. deputy medical superintendent, nursing superintendent, nodal officer of biomedical waste and in charge of Incinerator reflected on the potential gaps in the implementation of the Bio-medical Management Rules 2016. Through in-depth interviews the key informants explained that

it is the point of generation of the biomedical waste, where due to negligence of junior health professionals biomedical waste is not segregated as per the recommended schedule. The other issue is with the waste handlers. As waste handlers belong to the outsourced sanitation staff which keeps changing and rotating. So due to lack of knowledge handlers commit certain mistakes during collection, segregation, and packaging of the bio-medical waste. They sometimes mix municipal waste with the infectious waste or segregate the biomedical waste in wrong colour coded bins. Further all the informants agreed on satisfactory adoption of bio-medical waste guidelines by the nurses working in different departments. They were observed to follow the instructions carefully and take interest in training and education regarding waste handling and management. The institution felt the need for more allocation of resources related to tools and equipments related to biomedical waste management procedures.

This report has made essential recommendations to improve upon waste management process that should be implemented by the institution. As due to modifications in the bio-medical waste handling and management rules 1998 and introduction of waste management rules 2016 there are some areas of concerns which needs to be addressed by organizing regular trainings, demonstrations, and awareness workshops.

### **Limitation of the Study**

One of the limitations of this study is poor generalizability. The qualitative information generated by the study may suffer from bias. Indira Gandhi Medical College is one of the biggest and established healthcare institutions. The type and quantum of biomedical waste being generated in the institution may vary both in quality and quantity as compared to other peripheral health institutions of the State.

### **Competing Interests**

The author declares that he has no potential competing interests.

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