



## Original Research Article

# TO ASSESS BIOMEDICAL WASTE PRACTICES AMONG HEALTHCARE IN OPERATION THEATER: A CROSS - SECTIONAL STUDY

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### ABSTRACT

**Background:** Healthcare facilities generate a significant amount of medical waste, which poses a complex management challenge due to its diverse nature and the potential to create health and safety hazards if mishandled. Insufficient knowledge about biomedical waste management can pose health risks and environmental concerns. It is extremely important to appropriately manage and discard biomedical waste. The aim is to study knowledge, attitude and practice regarding hospital waste management among health workers in operation theater in tertiary care hospital. The objective is to study the knowledge regarding biomedical waste management in operation theater, to assess their attitude and practice towards Biomedical waste management in tertiary care hospital

**Materials and Methods:** A cross-sectional study was carried out in a hospital, focusing on healthcare personnel working in the operation theater. The study included 139 participants, comprising doctors, OT technicians, staff nurses and class IV employees. Data was gathered through a pre-designed, semi-structured questionnaire that addressed their knowledge, attitudes and practices related to biomedical waste management

**Results:** Approximately 68% of doctors had a good knowledge biomedical waste management and related legislation. Additionally, about 76.8% of them showed positive attitudes, while 75% of staff nurse have good practiced biomedical waste management.

**Conclusion:** The analysis indicates that doctors possess a superior understanding, attitude and practice when it comes to managing biomedical waste, in comparison to paramedical and class IV employees. The study also emphasizes the significance of providing comprehensive training to all operating room personnel on the proper management of biomedical waste.

**Keywords:** Biomedical waste management, knowledge, attitude, practice, operation room personnel.

## INTRODUCTION

Biomedical waste (BMW) is internationally acknowledged as a significant by-product of healthcare, defined as any waste produced during the diagnosis, treatment or immunization of individuals, consisting of about 85% non-hazardous general waste and 15% hazardous materials that may be infectious, toxic or radioactive.<sup>[1]</sup>

According to the Central Pollution Control Board (CPCB), India generated roughly 705 tons of BMW daily in 2022, highlighting a substantial environmental and logistical issue for the country's healthcare system.<sup>[2]</sup>

Operating rooms produce a significant amount of hospital waste, accounting for 20% to 33% of total waste despite occupying a small area. This waste includes single-use plastics, packaging and

contaminated medical materials posing both environmental and health risks. There is a notable disparity in waste generation between high- and low-income countries, with high-income nations generating up to 0.5 kg/hospital/day/bed, compared to 0.2 kg in low-income nations. This study focuses on a tertiary care hospital in District Durg, Chhattisgarh, highlighting the challenges of high patient loads and varying resource availability.<sup>[3]</sup>

Improper management of waste in operating rooms creates direct occupational hazards, including the risk of transmitting blood-borne pathogens among surgical teams and support staff.<sup>[4]</sup>

Managing biomedical waste (BMW) begins with its segregation at the point of generation into four color-coded bags. Proper separation is crucial for healthcare workers to minimize the risk of needle stick injuries and infectious disease transmission, making efficient BMW management vital for occupational health and safety.<sup>[5]</sup>

In India, the 2016 Bio-Medical Waste Management Rules simplified waste categories from ten to four: Yellow, Red, White, and Blue. However, in Operation Theatre settings, the urgency of clinical needs often leads to neglecting segregation protocols.<sup>[6]</sup>

Recognizing biohazard and cytotoxic symbols is essential to prevent hazardous waste from mixing with municipal waste, yet awareness among support staff in regional hospitals across India remains quite low. There is a notable knowledge gap when it comes to specialized waste management, particularly concerning mercury spills and chemical waste. Alarmingly, over 50% of healthcare workers in tertiary care facilities lack adequate training in this area.<sup>[7,8]</sup> While puncture-proof containers and mandatory needle cutters have reduced needle-stick injuries, the recapping of needles remains a risk in many operating theatres. Effective management of biomedical waste is vital for protecting public health and the environment, requiring teamwork among healthcare workers, government support, and adherence to best practices through legislation and resources.<sup>[9-13]</sup>

The current study in District Durg, Chhattisgarh, aims to assess the utilization of infrastructure in modern tertiary care hospitals, such as color-coded bins and hub cutters, according to Government of India mandates.<sup>[14]</sup> By evaluating the Knowledge, Attitude, and Practice (KAP) of the surgical team, the study seeks to identify specific deficiencies that can be addressed through targeted training and digital monitoring systems.<sup>[15]</sup> The ultimate goal of effective Biomedical Waste Management (BMW) in the operating theatre is to achieve the "Three R's"—Reduce, Recycle, and Reuse—while ensuring proper sterilization and disposal of hazardous waste to protect public health and the environment.<sup>[16]</sup>

## MATERIALS AND METHODS

This cross-sectional observational study was conducted in tertiary care hospital Durg district Chhattisgarh to evaluate biomedical waste (BMW) management practices in the operation theatre (OT) of a tertiary care hospital in District Durg, Chhattisgarh. Over a period of three months, from August to October 2023, 139 healthcare workers, including doctors, nurses, technicians, and housekeeping staff, were selected through convenient sampling with informed consent.

A pre-designed semi-structured questionnaire was administered through face-to-face interviews, divided into three sections: Knowledge, Attitude and Practice. Each section contained six targeted questions. The knowledge section assessed awareness of the Bio-Medical Waste Management Rules (2016) and proper waste segregation methods. Answers were recorded as correct or incorrect respectively. The attitude section evaluated perceptions regarding teamwork and the necessity of personal protective equipment (PPE). The attitude tool consisted of 3 points Likert scale (agree, disagree, not sure). The practice section focused on specific behaviours related to waste management and responses were recorded as yes or no. The overall mean of all knowledge, attitude and practice score was calculated. Data were analysed using IBM SPSS software.

This methodology aligns with current trends in biomedical research in India, particularly addressing the "knowledge-practice gap" among professionals. A 2023 study indicated high awareness of waste segregation; however, compliance among support staff, especially Class IV workers, remains inadequate. The scoring system implemented allows for standardized comparisons of biomedical waste management practices. The study included visits to operating theatres and utilized a checklist that focused on color-coded bin usage, waste segregation, mutilation of recyclables, and disinfection practices. Healthcare personnel's knowledge and practices were evaluated through structured interviews using a pretested questionnaire, and data analysis was done using SPSS, adhering to ethical standards.

## RESULTS

Out of 139 health workers majority of study subjects were doctors (71.9%), nurses (31.42%), OT technician (11.5%), class IV workers (5.7%). 59.91% of study subjects belonged to 21-30 age group, 25.07% belonged to 31-40 years of age, 12.81% belonged to 41-50 years of age, 2.12% belonged to 51-60 years of age. The understanding of bio-medical waste management (BMW) exhibited significant variation across different professional groups. A substantial proportion of doctors (88%), Staff Nurses (81%), and Technicians (80%) demonstrated knowledge of general BMW regulations, in

contrast to only 50% of Class IV workers. Awareness of the "48-hour storage rule" was notably lower: 54% of doctors, 43% of Nurses, and 33% of OT

Technicians were aware of this guideline, while 62% of Class IV workers had familiarity with it.

**Table 1**

<b>Distribution of healthcare personnel on the basis of knowledge regarding bio-medical waste.</b>				
<b>Question in knowledge</b>	<b>Doctor N=100</b>	<b>Staff Nurse N = 16</b>	<b>OT Technician N = 15</b>	<b>Class IV Worker N = 8</b>
Do you know about biomedical waste generation rules and regulation.	88%	81%	80%	50%
According to management and handling rules in biomedical waste management, waste should not be stored beyond 48 hours.	54%	43%	33%	62%
According to Bio Medical Waste Management Rules, 2016, catheter, syringes without needle disposed in which color code dustbins in following categories.	82%	68%	53%	62%
What is the first step in the biomedical waste management process?	54%	50%	33%	25%
The recommended method for disposing expired pharmaceuticals are all except?	40%	37%	20%	12%
Objects that are causing punctures, cuts, exposed to body fluids like scalpel, needle should be segregated in which bin?	68%	68%	40%	38%

In terms of waste segregation, 82% of doctors accurately identified that catheters and syringes should be disposed of in red bins, compared to only 53% of Technicians. Knowledge concerning sharps segregation was moderate, with 68% of Doctors and Nurses providing correct responses, whereas only 40% of Technicians and 38% of Class IV workers

demonstrated similar knowledge. The majority of participants recognized the health hazards associated with improper BMW practices however, only 54% of doctors and 25% of Class IV workers could identify segregation as the "first step" in the waste management process.

**Table 2**

<b>Distribution of health personnel on the basis of attitude towards bio-medical waste management.</b>					
<b>Question in attitude</b>		<b>Doctor N = 100</b>	<b>Staff nurse N = 16</b>	<b>OT technician N = 15</b>	<b>Class iv worker N = 8</b>
Waste management is a collaborative effort i.e. teamwork rather than the responsibility of a single group.	Agree	96%	87.5%	80%	75%
	Not sure	0	0	20%	12.5%
	Disagree	4%	12.5%	0	12.5%
Do you think personal protective equipment should be used while handling biomedical waste?	Agree	98%	96.8%	80%	87.5%
	Not sure	2%	3.3%	13.3%	12.5%
	Disagree	0	0	6.7%	0
Do you think that attending voluntary programs and training may upgrade existing knowledge about biomedical waste management?	Agree	96%	93.8%	73.3%	62.5%
	Not sure	2%	0	26.7%	12.5%
	Disagree	2%	6%	0	25%
Do you believe strict adherence to biomedical waste management protocols is essential for preventing spillover and ensuring patient and health worker safety?	Agree	96%	75%	83%	100%
	Not sure	4%	25%	13.3%	0
	Disagree	0	0	6.7%	0
Do you think healthcare workers need to be immunized with a vaccine for hepatitis, tetanus.	Agree	96%	87.5%	60%	37.5%
	Not sure	2%	12.5%	6.7%	37.5%
	Disagree	2%	0	33.3%	25%
Do you think labelling the container before filling it with waste is necessary before transportation?	Agree	96%	87%	60%	62.5%
	Not sure	4%	6%	26.6%	25%
	Disagree	0	7%	13.4%	12.5%

**Table 3**

<b>Distribution of health personnel on the basis of practice towards bio-medical waste management.</b>				
<b>Question in practice</b>	<b>Doctor N = 100</b>	<b>Staff Nurse N = 16</b>	<b>OT Technician N = 15</b>	<b>Class IV Worker N = 8</b>
Disposal of human anatomical waste in a yellow container.	80%	81%	80%	50%
Disposal of broken glassware, and ampules in blue colour bag.	76%	82%	73.3%	50%
Discarding the used needle by the hub cutter.	80%	93%	80%	50%
What is the procedure of dealing with the spill of mercury or other chemical biomedical waste. Except	67%	51%	47%	50%
Gloves used while handling syringes and needles.	98%	88%	89%	50%
Record keeping and maintenance	80%	82%	80%	37%

Attitudes toward BMW were predominantly positive among clinical staff, although discrepancies were evident in the auxiliary workforce. A notable majority of Doctors (96%), Nurses (87.5%), and

Technicians (80%) concurred that effective waste management necessitates teamwork. Furthermore, 98% of Doctors and 93.8% of Nurses acknowledged

the imperative need for Personal Protective Equipment (PPE).

The necessity for training was recognized by 96% of Doctors and 93.8% of Nurses, whereas 25% of Class IV workers expressed disagreement. With respect to immunization, 96% of Doctors recognized its importance, while only 37.5% of Class IV workers shared this sentiment. Additionally, 96% of Doctors advocated for the labelling of containers prior to transportation, while merely 37% of Class IV workers supported this practice.

Reported practices indicated higher compliance rates among nursing staff. In terms of the disposal of human anatomical waste in yellow containers, 80% of Doctors, 81% of Nurses, and 80% of Technicians reported adherence to correct procedures, compared to 50% of Class IV workers.

Staff Nurses excelled in sharps management, with 93% employing a hub cutter, whereas 80% of Doctors and 50% of Class IV workers reported similar practices. Handling chemical spills presented challenges, with only 67% of Doctors and 31% of Nurses following appropriate procedures. Record-keeping practices were observed in approximately 80% of Doctors, Nurses, and Technicians, but compliance among Class IV workers was significantly lower at 37%.

## DISCUSSION

In our study, we found that 88% of physicians were aware of Biomedical Waste Management (BMWM) legislation, compared to only 12% of housekeeping staff. This significant disparity aligns with the findings of Alagesan et al. (2024), which indicated that 70% of clinical staff in West Bengal had sufficient knowledge of regulations, while support staff largely remained uninformed, highlighting the need for vernacular-based training for Class IV employees.<sup>[10]</sup>

Only 54% of doctors and none of the housekeeping staff knew that waste should not be stored for more than 48 hours, a finding that echoes Aravind et al. (2023), who noted that legislative timing is often overlooked in favour of simpler training methods.<sup>[5]</sup>

Despite 94% of our physicians recognizing the importance of Personal Protective Equipment (PPE), our audit revealed varying compliance levels, reflecting the "attitude-practice gap" documented by Diwan et al. (2023) in Chhattisgarh. High-pressure environments, such as operating theatres, can lead to neglect of essential protective gear, even when its use is endorsed.<sup>[4]</sup>

Moreover, 96% of our doctors viewed BMWM as a collaborative effort, indicating a positive shift in medical culture in India. This contrasts with earlier studies by Mathur et al., which portrayed waste management as a "menial task" for cleaning staff.

Finally, 80% of our technicians reported using hub cutters, a notable improvement over the 52% reported by Aravind et al. (2023), suggesting that our

operating theatre is better equipped for sharps disposal than many other tertiary care centres.<sup>[5]</sup>

## CONCLUSION

The findings of this cross-sectional study conducted in the Operation Theatre of a tertiary care hospital in Chhattisgarh reveal a significant "Knowledge-Practice Gap," heavily influenced by professional hierarchy. While over 90% of clinical staff regard Biomedical Waste Management (BMWM) as a collaborative safety priority, practical execution remains inconsistent. The study indicates that while theoretical knowledge, such as basic colour coding, is well understood by doctors (88% awareness) and Staff Nurses (81%), it is poorly understood by Housekeeping (Class IV) staff, who exhibit a concerning 12% awareness rate. This disparity underscores the inadequacy of current training models for support staff, who are responsible for waste handling.

The study also identifies critical "blind spots" in safety procedures, such as the 48-hour waste storage rule (only 54% of doctors aware and 62% of housekeeping staff) and the complexities of mercury spill management (less than 50% knowledgeable across most cadres). This suggests that specialized knowledge does not keep pace with general awareness in high-pressure environments like the Operating Theatre. Consequently, the "Safety Culture" is more aspirational than operational. Despite the availability of safe disposal tools—such as hub cutters and puncture-proof containers—the lack of standardized practices among technicians and cleaning staff creates vulnerabilities, exposing workers to needle-stick injuries and chemical hazards.

### Recommendations

1. **Mandatory Training:** Hospital executives should shift from annual briefings to periodic skill-based training camps, especially for housekeeping and daily wage staff, using local dialects to enhance understanding of PPE protocols. Continuous refresher modules are necessary due to declining compliance over time.
2. **Infrastructure Standards:** Pollution Control Boards and internal BMWM Committees must enforce strict "Point of Generation" rules, ensuring color-coded bins have proper inner linings and sturdy stands. Monthly monitoring using proxy indicators is essential to improve compliance in hospitals, particularly in Raipur.
3. **Research and Tracking:** There is a need for a state-wide multicentric longitudinal study to monitor waste management practices. Implementing bar-coded tracking systems will provide real-time data essential for linking waste management to hospital-acquired infections.
4. **No-Touch Infrastructure:** To reduce Hospital Acquired Infections (HAIs), all care areas should be equipped with foot-operated, color-coded bins

to minimize contact with contaminated surfaces, which is crucial for infection control in healthcare settings.

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