

Awareness of Biomedical Waste Management among Nursing Students: A Hospital Based Study in BiharRajesh Ranjan Sinha¹, Kislay Parag², Aishwarya Krishna³, Ajay Krishna⁴¹Professor, Department of Community Medicine, Patna Medical College, Patna, Bihar, India²Tutor, Department of Community Medicine, BMIMS, Pawapuri, Nalanda, Bihar, India³JR-2, Department of Pathology, Patna Medical College, Patna, Bihar, India⁴Associate Professor cum Head of Department, Department of Community Medicine, Patna Medical College, Patna, Bihar, India

Received: 16-08-2023 / Revised: 28-09-2023 / Accepted: 05-10-2023

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Conflict of interest: Nil

Abstract**Introduction-** Biomedical waste is of global subject today. The biomedical waste (management and handling) rules came into existence in 1998 with the latest amendment being made in 2019.**Methods-** This descriptive cross-sectional study was carried among 163 nursing students to assess the knowledge, attitude, and practices regarding biomedical waste management using total enumeration method. Nursing students who had clinical exposure >6 months and willing to participate were included in the study. Nursing students who were in their 1st academic year were excluded. The questionnaire was divided into four components assessing knowledge, attitude, and practices regarding biomedical waste management. The obtained scores of participants were converted into percentages and categorized as excellent (> 70%) and poor (< 70%).**Results-** Mean age of participants was 21.54 + 2.49 years with the majority being female (81.6%) and studying in B.Sc. nursing (59.5%). Majority of participants had poor level of knowledge in various domains of biomedical waste management like awareness (78.5%), color coding (84.7%), biomedical waste disposal methods (92.6%), and universal precautions (97.5%) except for biomedical waste hazard symbol (15.3%). About 95.1% of participants had overall poor knowledge regarding biomedical waste management. Nearly 76.1% and 74.2% of participants showed positive attitudes and safe practice patterns respectively.**Conclusion-** Although nursing student's attitudes and patterns of practice were excellent yet they had an unsatisfactory level of knowledge related to recent amendments in biomedical waste management rules. Regular teaching and periodic monitoring of practices regarding biomedical waste are highly recommended.**Keywords-** knowledge, attitude, practices, biomedical waste, nursing studentThis is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

“Biomedical waste is waste generated during diagnosis, treatment, or immunization of human beings or animals, or in research activities pertaining thereto, or in the production and testing of biological and is contaminated with human fluids”. [1] The majority (75-90 %) of the health care-generated wastes are general waste or having no risk as such and the remaining are hazardous wastes. [2] Rapid population growth and increased demand for health care have significantly increased health care institutions. [3] Ironically, hospitals that are centers for care and treatment are also possessing threat to patient's health and safety [4] by generating a significant amount of biomedical waste.

The biomedical waste (management and handling) rules came into existence in 1998 and subsequent amendments have been made in 2000, 2003, 2016, and 2018 [5]. As per the latest amendments, centers

of biomedical waste generation such as hospitals will not use chlorinated plastic bags and gloves in medical applications to save the environment. [6] Recent amendments have made bar code systems mandatory for proper control of biomedical waste. It has also increased coverage to include healthcare waste produced at home. [7]

Biomedical waste is of global subject today. Inadequate and insufficient knowledge, attitude, and practices concerning biomedical waste control have excessive potential for injury and contamination to self in addition to others and can additionally have severe environmental consequences. [7, 8] There are strong shreds of evidence to show transmission of life-threatening diseases such as HIV/AIDS, Hepatitis B, and C through improper biomedical waste management. [9]

Developed countries have reported increased awareness while developing countries such as India, have reported poor knowledge, attitude, and practices regarding biomedical waste management among health care workers. [7, 10-12] It is not only legal but also social responsibility of every health care professional to ensure proper disposal of health care generated waste on their part. Some research evidence suggests that knowledge regarding biomedical waste management among students is not appropriate. [13]

Teaching institutions with attached hospitals have an important duty towards society to train nursing students such that they can manage biomedical wastes efficiently. Practices during early careers remain permanent and do not change easily. Nursing students need to be equipped with good knowledge, attitude, and practices regarding recent amendments and advancements to ensure optimal compliance with biomedical waste management rules. Most of the studies are carried out among health care workers but to the best of author's knowledge, there are no such studies which have assessed gaps in knowledge, attitude, and practices concerning biomedical waste management amongst nursing students. Hence the present study was undertaken with the objective to assess the knowledge, attitude, and gaps in the practices regarding the biomedical waste management, so that future teaching and skill training can be arranged for the students.

Material and Methods

The present non-experimental descriptive cross-sectional study was carried out at two private nursing colleges to assess knowledge, attitude, and practices level among nursing students in the first week of June 2023 using total enumeration method. Necessary permissions were obtained from the concerned authority. Objectives of the study were clearly mentioned and participants were given option to withdraw from the study if appropriate. All participants were assured about the confidentiality and anonymity of the obtained information.

Considering the prevalence of knowledge about biomedical waste management rules as 10% [14] in nursing students at 95% Confidence Interval with 5% precision, the sample size was calculated to be 141. The inclusion criteria included the nursing students who had clinical exposure of >6 months and willing to participate in the study. Nursing students who were in their 1st academic year were excluded from the study. All nursing students who fulfilled inclusion criteria were invited through WhatsApp and mail to participate in the study. A total of 163 nursing students participated in the present study. After an extensive review of literature and consultation with subject experts, a structured

online self-administered knowledge, attitude, and practices questionnaire was developed using web-based Google forms with attached information sheet and instructions, which went through the process of content and face validity by experts. The questionnaire was divided into four components.

Part I comprised of socio-demographic proforma which included age, gender, educational qualifications, type of residence, marital status, type of family, and family income per month. Part II contained 20 multiple-type questions covering five dimensions of knowledge related to biomedical waste management namely awareness, color coding, biomedical waste disposal methods, universal precautions, and biomedical waste hazard symbol. Part III included 10 attitude-related questions on Likert scale (Agree, Ascertain, Disagree) assessing both positive and negative attitudes regarding biomedical waste management. Part IV comprised of 10 questions related to practices among nursing students about biomedical waste management in positive or negative response format (Yes/No).

Each participant was given one score for each correct answer and zero scores for each wrong answer in knowledge and practices components of the tool while for positive attitude, a score of two was given for agree, one for ascertain and zero for disagree, and for the negative attitude, a score of two was given for disagree, one for ascertain and zero for agree, thus maximum possible scores of each participant for knowledge, attitude and practices were 20, 20 and 10 respectively. Considering the criticality of biomedical waste hazards, the obtained knowledge, attitude, and practices scores of participants were converted into percentages and categorized as excellent (> 70%) and poor (< 70%).

Statistical Analysis

The collected data were coded and then summarized in master data sheet using Microsoft Excel spreadsheet. Data analysis was done by statistical program SPSS 20.0 version using both descriptive and inferential statistics. Frequency, percentage, mean, standard deviation, and range were calculated in descriptive statistics. Chi-square test was used to find out the association between knowledge and practice levels among nursing students. The level of significance was set at p-value <0.05.

Result

A total of 163 nursing students participated in the study. Mean age of participants was 21.54 ±2.49 years with the majority being female (81.6%) and studying in B.Sc. nursing (59.5%). About half of the participants belonged to nuclear families (52.8%) and having a family monthly income

of Rs. < 10,000 (47.9%) (Table 1).

Table 1: Socio-demographic characteristics of participants (N=163)

	Frequency (%)
Age (years) Mean \pm SD (Range)	21.54 \pm 2.49 (18-32)
Gender Male Female	30 (18.4) 133 (81.6)
Course GNM P.B. B.Sc. (N) B.Sc. (N) M.Sc. (N)	52 (31.9) 6 (3.7) 97 (59.5) 8 (4.9)
Type of residence Rural Urban	115 (70.6) 48 (29.4)
Marital status Married Unmarried	13 (8.0) 150 (92.0)
Type of family Nuclear Joint	86 (52.8) 77 (47.2)
Family income (per month) Rs. < 10,000 Rs. 10,000 - 40,000 Rs. 40,000 - 1,20,000 above Rs 1,20,000	78 (47.9) 69 (42.3) 13 (8.0) 3 (1.8)

Table 2: Domain-wise knowledge related to biomedical waste management among participants (N=163)

Domain (items)	Knowledge, Frequency (%)	
	Excellent	Poor
Awareness (2)	35 (21.50)	128 (78.5)
Colour coding (6)	25 (15.3)	138 (84.7)
Biomedical waste disposal methods (6)	12 (7.4)	151 (92.6)
Universal precautions (5)	4 (2.5)	159 (97.5)
Biomedical symbol (1)	138 (84.7)	25 (15.3)

Table 2 illustrates domain-wise knowledge related to biomedical waste management among study participants. Unfortunately, the majority of participants had poor level of knowledge in various domains of biomedical waste management like awareness (78.5%), color coding (84.7%), biomedical waste disposal methods (92.6%), and universal precautions (97.5%) except for biomedical hazard symbol (15.3%).

Table 3 clearly explains the attitude of nursing students regarding biomedical waste management. Majority (93.3%, 91.4%, and 93.9%) of participants agreed that color-coding system is a simple method for segregating biomedical waste, wearing gloves is necessary to prevent medical waste hazards, and always putting waste in correct plastic bag respectively. About two-third (62% and 62.6%) participants agreed that biomedical waste can harm the health of the public at large, and all waste

generated in hospital are infectious respectively. More than two in three participants disagreed that biomedical waste is an extra burden on their work (69.3%) and wearing PPE increases the risk of infection (68.7%). About 87.7% were willing to attend an educational program on biomedical management.

Majority of participants ensure tying up the waste bag when it is 3/4th filled (76.7%), a practice of not recapping the used needles (60.7%), dispose-off biomedical waste in the specified color-coded container (96.3%), discard used needles in needle destroyer (88.3%), record and report needlestick and sharps injury (84.0%) and change gloves between patients (81.6%). Only 66.9% and 81.6% of participants were vaccinated against Hepatitis B and TT respectively. Sadly, 60.7% had previous exposure to needle stick or sharps injury.

Table 3: Attitude regarding biomedical waste management among participants, (N=163)

	<i>Attitude, Frequency (%)</i>		
	<i>Agree</i>	<i>Uncertain</i>	<i>Disagree</i>
Positive The color-coding system is a simple method for segregating bio-medical waste.	152 (93.3)	3 (1.8)	8 (4.9)
Biomedical waste can harm the health of the public at large.	101 (62.0)	18 (11.0)	44 (27.0)
Sharp injuries/accidents have to be reported to the concerned authority	136 (83.4)	12 (7.4)	15 (9.2)
Gloves should be worn to avoid the risk of medical waste.	149 (91.4)	7 (4.3)	7 (4.3)
Always put the waste in the correct plastic bag	153 (93.9)	5 (3.1)	5 (3.1)
Hand hygiene should be performed between two patients	122 (74.8)	10 (6.1)	31 (19.0)
Are you willing to attend an educational program on biomedical waste management?	143 (87.7)	9 (5.5)	11 (6.7)
Negative Biomedical waste is an extra burden on my work	37 (22.7)	13 (8.0)	113(69.3)
Wearing PPE increases the risk of infection	47 (28.8)	4 (2.5)	112(68.7)
All waste generated in hospital are infectious	102 (62.6)	13 (8.0)	48 (29.4)

Table 4: Practices regarding biomedical waste management among participants, (N=163)

	<i>Practices, Frequency (%)</i>	
	<i>Yes</i>	<i>No</i>
Segregate waste at the point of generation	140 (85.9)	23 (14.1)
Ensure tying up the waste bag when it is 3/4 th filled	125 (76.7)	38 (23.3)
Practice not recapping the used needles	99 (60.7)	64 (39.3)
Dispose-off biomedical waste in the specified color-coded container	157 (96.3)	6 (3.7)
Discard used needles in needle destroyer	144 (88.3)	19 (11.7)
Record and report needlestick and sharps injury	137 (84.0)	26 (16.0)
Have you taken vaccination against Hepatitis B?	109 (66.9)	54 (33.1)
Have you taken vaccination against TT?	133 (81.6)	30 (18.4)
Previous exposure to needle stick or sharps injury?	99 (60.7)	64 (39.3)
Change gloves between patients	133 (81.6)	30 (18.4)

Table 4 depicts practices regarding biomedical waste management among participants. About 85.9% of participants segregate waste at their generation point.

Table 5 shows that mean scores + SD of knowledge, attitude and practices was 9.52 ± 2.49 , 15.66 ± 2.69

and 7.83 ± 1.85 respectively. Overall knowledge of participants was poor for 155 (95.1%) while 124 (76.1%) and 121 (74.2%) participants were having excellent overall attitudes and practices respectively.

Table 5: Overall knowledge, attitude, and practices related to biomedical waste management among participants (N=163)

	<i>Mean</i>	<i>Frequency (%)</i>	
		<i>Excellent</i>	<i>Poor</i>
Knowledge	9.52 ± 2.49	8 (4.9)	155 (95.1)
Attitude	15.66 ± 2.69	124 (76.1)	39 (23.9)
Practices	7.83 ± 1.85	121 (74.2)	42 (25.8)

Table 6 illustrates that there is no statistically significant association between sociodemographic variables and knowledge levels concerning biomedical waste management.

Table 6: Association between sociodemographic variables and biomedical waste management knowledge levels

<i>Sociodemographic variables</i>	<i>Knowledge level</i>		<i>Chi-square value</i>	<i>df</i>	<i>p-value</i>
	<i>Excellent n (%)</i>	<i>Poor n (%)</i>			
<i>Gender</i>					
Male	7 (87.5)	126 (81.6)	0.195	1	0.659 ^{NS}
Female	1 (12.5)	30 (18.4)			
<i>Course</i>					
GNM	0 (0)	52 (33.5)	5.982	3	0.112 ^{NS}
P.B. B.Sc. (N)	1 (12.5)	5 (3.2)			
B.Sc. (N)	7 (87.5)	90 (58.1)			
M.Sc. (N)	0 (0)	8 (5.2)			
<i>Type of residence</i>					
Rural	6 (75.0)	109 (70.3)	0.80	1	0.777 ^{NS}
Urban	2 (25.0)	46 (29.7)			
<i>Marital status</i>					
Married	1 (12.5)	12 (7.7)	0.235	1	0.628 ^{NS}
Unmarried	7 (87.5)	143 (92.3)			
<i>Type of family</i>					
Nuclear	3 (37.5)	83 (53.5)	0.786	1	0.375 ^{NS}
Joint	5 (62.5)	72 (46.5)			
<i>Family income (per month)</i>					
Rs. < 10,000	4 (50)	74 (47.7)	0.425	3	0.935 ^{NS}
Rs. 10,000 - 40,000	3 (37.5)	66 (42.6)			
Rs. 40,000 - 1,20,000	1 (12.5)	12 (7.7)			
above Rs 1,20,000	0 (0)	3 (1.9)			

NS- Not Significant

Discussion

An appropriate knowledge, positive attitude, and good level of practice are crucial factors for proper biomedical wastes management. The present study uncovered that the level of knowledge regarding recent amendments in biomedical waste management rules, among nursing students was poor yet they reflected positive attitudes and good practice patterns. Health care providers are at the frontline in the management of biomedical waste and inadequate knowledge and improper practices among them would be a potential threat to not only to themselves as well as for others also.

Only a few studies carried out knowledge, attitude, and practices regarding recent amendments in biomedical waste management rules among nursing/medical students and health care providers. The present study was carried out among nursing students only. In our study, there was highly unsatisfactory level of knowledge with nearly 95.1%

of participants falling in the poor knowledge category, which is exceedingly more when compared to several studies conducted among nurses. [13, 15, 16] Other studies showed poor knowledge levels among nursing students when compared to medical students regarding biomedical waste management. [18-20] In contrast to the present study, several other studies showed good/adequate knowledge levels among nurses. [9, 17, 21] Another study showed adequate knowledge among nursing students regarding biomedical waste management. [11] Nursing student needs to improve their knowledge and translate it into their clinical practice.

Knowledge regarding color coding, disposal methods, universal precautions, and biomedical waste hazard symbols are crucial for the effective management of biomedical waste. In the present study, the majority of students were having poor knowledge levels regarding various domains of biomedical waste management namely awareness,

color coding, biomedical waste disposal methods, and universal precautions, which was in contrast to other studies. [4, 18] Nursing students were having an excellent level of knowledge regarding biomedical hazard symbols, which is in line with other studies. [4, 18]

Nursing students had an excellent attitude regarding biomedical waste management which is comparable to studies among nursing students. [5, 10] Studies conducted among nurses and health care workers also showed positive attitude [11, 15, 17] while negative attitude was also shown among nurses. [3] A study reported poor attitude among resident doctors regarding biomedical waste management in comparison to nursing staff. [7]

The practices among nursing students regarding biomedical waste management were excellent which was in contrast with studies that showed poor pattern of practices among nurses and nursing students. [10, 16] Other studies conducted among nurses showed good level of practice among nurses which was in line with the present study. [7, 11, 13, 17]

In our study, about 40% of nursing students reported unsafe practices of recapping used needles which may expose them to needle stick injury. This was in contrast with a study that reported higher recapping practices among nurses. [15] Agonizingly, about 60% of nursing students had previous exposure to needle stick or sharps injury.

In our study, we found out that about one in three participants were not vaccinated against Hepatitis B (33.1%) which is in line with another study that showed 20.7% of nurses were not vaccinated against Hepatitis B. [11] In our study, one in five nursing students were not vaccinated against TT (18.4%). So it should be made mandatory for all nursing students to get vaccinated against Hepatitis B and TT (every 5 years) before entering their clinical posting.

Several research evidences are available which suggest that biomedical waste management is widespread problem across countries. [22] Some studies reported better knowledge but poor practices regarding biomedical waste management among nursing students when compared to nursing staff. [3, 4] Another study showed better biomedical waste management practices among medical students than nursing students. [10]

Since biomedical waste management is part of the nursing curriculum, the findings of the study are staggering for nurse educators. It is a need of the hour for nursing students to be abreast with recent amendments in rules and policies regarding biomedical waste management as they will be future health care providers. Clear written guidelines and policies concerning biomedical management with regular enhancements should be made for nursing students.

This comprehensive study includes an adequate sample size. We are aware that there may be over-reporting of desirable responses due to self-report bias. Positive attitudes and good practices for biomedical waste management may be due to social desirability bias, but they may be weak. In future studies, health care workers from different centers with large sample sizes are warranted to explore the relationship between knowledge and practices regarding recent amendments in biomedical waste management rules. Regular teaching and training about recent amendments as well as newer safe and cost-effective scientific methods of waste management and periodic monitoring of practices regarding biomedical waste are highly recommended.

Conclusion

Although nursing student's attitudes and patterns of practice were excellent on the other hand they had an unsatisfactory level of knowledge related to recent amendments in biomedical waste management rules, 2019. Periodic assessment and regular teaching along with hands-on training programs with an emphasis on recent amendments in rules should be stressed to bridge the gap between knowledge, attitude, and practices.

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