



A Knowledge, Attitude and Practice Study of Biomedical Waste Management and Bio-safety among Healthcare Workers in a Tertiary Care Government Hospital in Western India

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ABSTRACT

Introduction: Inappropriate handling of biomedical waste has led to increasing incidence of hospital acquired infections. **Objective:** To analyze the Knowledge, Attitude and Practice of biomedical waste management and bio-safety among health care workers in a tertiary care hospital in Western India.

Methodology: A questionnaire based Knowledge, Attitude and Practice (KAP) study was carried out. Total 210 healthcare workers had participated, which included 68 laboratory technicians, 69 nurses and 73 resident doctors.

Results: Only 35.23% (74) participants knew the waste storage time limit. Awareness about pretreatment of the waste was found only in 5.8% (4) nurses. Awareness about post exposure prophylaxis is only 38% (81). More than 90% of the participants had positive attitude towards the subject. 40% (86) participants and 14% (10) nurses were practicing segregation at point of generation. Biomedical waste bag labeling practices were followed by only 23.2% (16) nurses and 27.39% (20) doctors. Knowledge and practices scores were better among technicians and doctors than nurses. Trained participants had better attitude and practice scores compared to untrained ones.

Conclusion: Intensive training programs at regular intervals are essential with special focus on nurses and first year resident doctors.

Keywords: Biomedical waste management; Bio-safety; KAP study

INTRODUCTION

Biomedical waste means any waste, which is generated during the diagnosis, treatment, or immunization of human beings or animals, or in research activities pertaining thereto or in the production or testing of biologicals.¹ Healthcare facilities including laboratories generate a huge amount of non-hazardous and hazardous wastes. Disposables medical devices and items generate biomedical waste beyond one's expectation.²

Biomedical waste collection, storage and disposal in appropriate manner have become a significant concern for both medical and general community.

Inadequate and inappropriate handling of healthcare waste along with poor infection control has led to increasing incidence of hospital acquired infections in health-care providers. At the global level 16-84% of the hospitals did not stick to the norms of biomedical waste management. Most of the healthcare workers had unsatisfactory practices with respect to biomedical waste management in India.³ Every concerned health worker is expected to have proper knowledge, attitude and practice for biomedical waste management.⁴⁻⁷

Our hospital is a tertiary care hospital functional since many years where the protocols & policies are in a place regarding biomedical waste man-

agement but never analyzed or accessed. Hence this study was undertaken with the objective to analyze the Knowledge, Attitude and Practice of biomedical waste management and bio-safety among health care workers, so that the gaps in the knowledge, attitude and practice of effective BMW management by the healthcare workers in our hospital can be identified. Accordingly the future training of the Healthcare workers can be planned and necessary steps can be taken to ensure proper and effective biomedical waste management.

METHODOLOGY

A Knowledge, Attitude and Practice (KAP) study was carried out after ethical approval from Institutional Review Board in the month of May 2017. A total of 210 healthcare workers of a Government tertiary care hospital in western India participated in the study. A written informed consent was obtained from each participant.

Three groups of participants were made: Group A- Laboratory technicians (n=68), Group B- Nurses (n=69) and Group C- Resident doctors (n=73). We have divided each group into 2 subgroups for detailed analysis: Group A1 : Laboratory technicians with <10 years of experience (n=44), Group A2: Laboratory technicians with >10 years of experience (n=24), Group B1 : Nurses with <10 years of experience (n=24), Group B2 : Nurses with >10 years of experience (n=45), Group C1 : First year resident doctors (n=28) and Group C2 : Second year resident doctors (n=45).

The tool used for collection of data was a structured questionnaire which has questions concerning the knowledge, attitude and practices on the subject. There were forty such questions. The participants were well informed about the purpose of study and about the questionnaire by investigators prior to data collection. Confidentiality of all the data was maintained.

After collecting the data, data were tabulated before data analysis. Government of India has notified the Biomedical Waste (Management and Handling) rules 1998 with subsequent amendments (June 2nd 2000, September 2003 and 2011). Though the rules have been revised in 2016 but revised rules are yet to be implemented in most of the health care facilities. Most of the health care facilities in India still follow the biomedical waste rules 1998. So we have analyzed all the responses of participants as per Biomedical Waste (Management and Handling) rules 1998.

Descriptive statistics i.e. percentage, mean and standard deviation was used to describe studied variables.

RESULTS

Profile of participants with respect to variables like gender, educational qualification, healthcare experience and vaccination status is shown in Table 1.

Table 1: Profile of Participants

Variable	Health Care Workers (%)
Gender	
Male	64 (30.4 %)
Female	146 (69.5%)
Educational Qualification	
Undergraduates	200 (95.2%)
Postgraduates	10 (4.7%)
Healthcare Experience	
<10 years	141 (67.14%)
>10 years	69 (32.8%)
Vaccinated	
Only Hepatitis B vaccine taken	50 (23.8%)
Only Tetanus toxoid taken	4 (1.9%)
Both Hepatitis B vaccine and Tetanus toxoid taken	121 (57.6%)
Not vaccinated	35 (16.6%)

Approximately 80% of the participants were aware about biomedical waste management rules proposed year as well as the objectives of biomedical waste management. In this study 74.28 % (n=156) participants were aware about the reasons why biomedical waste is dangerous and 98.09% (n=206) were aware about the major risks associated with it. Only 14.5 % (n=10) nurses could correctly point out infectious waste. Shockingly, only 18.8% (n=13) nurses knew that segregation is the most important step of biomedical waste management. Biohazard symbol was correctly recognized by 92.38% (n=194) participants. Correct knowledge regarding the maximum time limit for biomedical waste storage was observed only in 35.23 % (n=74) of the participants, poorest being the nurses group of only 11.6 % (n=8). 66.66% (n=140) participants knew about bags disposed by incineration. Strikingly, only 5.8% (n=4) nurses knew which color coded bags require pretreatment. Though 90% of the participants (n=190) were aware whom to report in case of needle stick injury, but only 38% (n=81) were aware when to take Post exposure prophylaxis, least in nurses only 15.9% (n=11). (Table 2).

Substantially 95.23% (n=200) participants believed that biomedical waste rules are applicable to them. Only 40% (n=84) participants believed that their knowledge regarding biomedical waste is not adequate and 54.28 % (n=114) of the participants agreed that they had received training in biomedical waste management. Approximately 93% participants felt that these rules should be a part of their curriculum mandatorily.

Table 2: Correct responses for questions on Knowledge regarding biomedical waste

Objective of Question	Group A	Group B	Group C	Total
	Technicians	Nurses	Doctors	
Awareness and year of first proposal of Biomedical rules	67 (98.53)	49 (71)	57 (78.08)	173 (82.38)
Objectives of biomedical waste management	56 (82.35)	45 (65.2)	66 (90.41)	167 (79.52)
Reason why Biomedical waste is more dangerous	48 (70.58)	40 (58)	68 (93.15)	156 (74.28)
Major risks associated with hospital waste handling	66 (97.05)	68 (98.6)	72 (98.63)	206 (98.09)
Differentiate between infectious and noninfectious waste	55 (80.88)	10 (14.5)	60 (82.19)	125 (59.52)
% of general & healthcare waste generated by healthcare activities	56 (82.35)	24 (34.8)	55 (75.34)	135 (64.28)
Most important aspect of BMW waste management is segregation	41 (60.29)	13 (18.8)	41 (56.16)	95 (45.23)
Identification of symbol used for biohazard	67 (98.52)	59 (85.5)	68 (93.15)	194 (92.38)
Maximum storage time limit for untreated waste	38 (55.88)	8 (11.6)	28 (38.35)	74 (35.23)
Color coded bag treated by incineration	62 (91.17)	38 (55.1)	40 (54.79)	140 (66.66)
Color coded bag not requiring pretreatment	50 (73.52)	4 (5.8)	39 (53.42)	93 (44.28)
After exposure Post Exposure Prophylaxis should ideally be taken within: a)2 hours* b)4 hours c)24 hours d) It can be taken anytime	39 (57.35)	11 (15.9)	31 (42.46)	81 (38.57)
Whom to report in case of needle stick injury	66 (97.05)	61 (88.4)	63 (86.30)	190 (90.47)

Figure in the parenthesis indicate percentage; BMW=Biomedical waste

Table 3: Number of positive responses for questions on Attitude regarding biomedical waste

Objective of Question	Group A	Group B	Group C	Total
	Technicians	Nurses	Doctors	
Applicability of biomedical waste rules to participants	68 (100)	66 (95.7)	66 (90.41)	200 (95.23)
Perception of their knowledge regarding BMW management	52 (76.47)	43 (62.3)	32 (43.83)	127 (60.47)
Training regarding biomedical waste management	43 (63.23)	47 (68.1)	24 (32.87)	114 (54.28)
BMW management should compulsorily be made a part of curriculum	63 (92.64)	65 (94.2)	68 (93.15)	196 (93.3)
Willingness to attend programmes that enhance and upgrade knowledge on BMW management.	68 (100)	66 (95.7)	63 (86.30)	197 (93.80)
Do you feel that colour coding of bins should be strictly implemented for successful BMW management?	64 (94.11)	64 (92.8)	63 (86.30)	191 (90.95)
Importance of labelling biomedical waste bag	64 (94.11)	66 (95.7)	65 (89.04)	195 (92.8)
Need of separate vehicle to transport biomedical waste	64 (94.11)	67 (97.1)	62 (84.93)	193 (91.9)
Waste management is a team work	58 (85.29)	57 (82.6)	58 (79.45)	173 (82.38)
Tie up with authorized company required for proper disposal of BMW	50 (73.52)	49 (71)	37 (50.68)	136 (64.76)
Frequency of health check-ups and training for healthcare workers	34 (50)	21 (30.4)	22 (30.13)	77 (36.66)
Safe management of BMW is a financial burden to the setup	54 (79.41)	31 (44.9)	55 (75.34)	140 (66.66)

Figure in the parenthesis indicate percentage; BMW=Biomedical waste

Table 4: Number of correct responses for questions on Practice regarding biomedical waste

Objective of Question	Group A	Group B	Group C	Total
	Technicians	Nurses	Doctors	
Site of segregation of the waste was at the point of generation.	31 (45.58)	10 (14.5)	45 (61.64)	86 (40.95)
Availability of all color coded bins for biomedical waste	41 (60.29)	19 (27.5)	28 (38.35)	88 (41.90)
Procedure followed to discard used gloves	59 (86.76)	44 (63.8)	28 (38.35)	131 (62.38)
Procedure followed to dispose needles	68 (100)	64 (92.8)	65 (89.04)	197 (93.80)
Color coded bin used to dispose soiled dressings	59 (86.76)	66 (95.7)	58 (79.45)	183 (87.14)
Color coded bin used to dispose intravenous infusion sets	57 (83.82)	60 (87)	61 (83.56)	178 (84.76)
Details on the label on bags for transportation of BMW	36 (52.94)	16 (23.2)	20 (27.39)	72 (34.28)
Amount of waste to be filled in waste bag	54 (79.41)	30 (43.5)	44 (60.27)	128 (60.95)
Mode of transportation of biomedical waste in hospital	60 (88.23)	58 (84.1)	49 (67.12)	167 (79.5)
Availability of incinerator facility in hospital	42 (61.76)	17 (24.6)	34 (46.57)	93 (44.28)
Mixing of pretreated biomedical waste with municipal waste	60 (88.23)	44 (63.8)	62 (84.93)	166 (79.0)
Method to prepare 1 liter of 1% sodium hypochlorite solution from available 5% strength	56 (82.35)	28 (40.6)	31 (42.46)	115 (54.76)
Procedure to manage the blood spillage on the floor	49 (72.05)	30 (43.5)	46 (63.01)	125 (59.52)

Figure in the parenthesis indicate percentage; BMW=Biomedical waste

Table 5: Correct responses for questions on Knowledge, Attitude and Practice regarding biomedical waste among laboratory technicians, nurses and doctors

	Knowledge		Attitude		Practice	
	Freq (%)	Mean±SD	Freq (%)	Mean±SD	Freq (%)	Mean±SD
Group A (Technicians)	54.69 (80.43)	10.45± 2.08	56.83 (83.57)	10.02±1.29	51.26 (75.39)	11.30±2.13
Group B (Nurses)	33.07 (47.9)	6.2±1.64	53.5 (77.5)	8.92±1.45	39.7 (57.5)	8.63±1.5
Group C (Doctors)	52.92 (72.49)	9.42±2.06	51.2 (70.2)	7.9±2.17	45.2 (61.9)	9.28±2.61

SD : Standard Deviation; Figure in the parenthesis indicate percentage

Table 6: Mean scores of correct responses for question on Knowledge, Attitude and Practice regarding biomedical waste among subgroups of Laboratory technicians, nurses and doctors

Participants	Knowledge Mean score (%)	Attitude Mean score (%)	Practice Mean score (%)
Group A1: Technicians with <10 years of experience	35.15 (79.89)	36.9 (83.9)	32.73 (74.39)
Group A2: Technicians with >10 years of experience	19.53 (81.41)	19.91 (82.98)	18.53 (77.2)
Group B1: Nurses with <10 years of experience	13.07 (54.48)	17.91 (74.65)	14.13 (58.88)
Group B2: Nurses with >10 years of experience	19.46 (44.23)	34.91 (79.35)	25 (56.81)
Group C1: Resident doctors (1 st year)	19.46 (69.45)	20.08 (71.72)	16.8 (60)
Group C2 : Resident doctors (2 nd year)	33.46 (74.35)	31.16 (69.25)	28.4 (63.1)

Figure in the parenthesis indicate percentage;

Table 7: Mean score and percentage of correct responses for question on Knowledge, Attitude and Practice regarding biomedical waste among trained and untrained Laboratory technicians, nurses and doctors

Domain	Technician (Mean score)		Nurses (Mean score)		Doctors (Mean score)		Total (Mean score)	
	Trained	Untrained	Trained	Untrained	Trained	Untrained	Trained	Untrained
Knowledge	10.32 (79.3)	10.68 (82.15)	6.19 (47.6)	6.31 (48.5)	9.75 (75)	9.26 (71.2)	8.5 (65.3)	8.9 (68.4)
Attitude	10.25 (85.41)	9.64 (80.33)	9.80 (81.6)	8.22 (68.5)	9.16 (76.3)	8.06 (67.1)	9.84 (82)	8.5 (70.8)
Practice	11.34 (75.6)	11.24 (74.9)	8.48 (56.5)	8.95 (59.6)	10.16 (67.7)	8.89 (59.2)	9.92 (66.13)	9.5 (63.3)

Figure in the parenthesis indicate percentage;

They were interested to attend training programmes that enhance and upgrade their knowledge regarding the topic. More than 90% participants believed that strict color coding implementation, labeling bags and separate vehicle for waste transport are essential for successful biomedical waste management. Predominantly 82.38% (n=173) participants felt that biomedical waste management is a team work. Need for tie up with authorized company for proper disposal of biomedical waste is felt necessary by 64.76% (n=136) participants. However, 66.66% (n=140) participants think that biomedical waste management is a financial burden to the hospital. (Table 3)

Segregation of the waste at the point of generation was done by 40.95% (n=86) participants and only 14.5% (n=10) nurses. Overall 41.9% (n=88) participants and only 27.5% (n=19) nurses were using all the recommended color coded bins for segregation of biomedical waste correctly. Only 38.35% (n=28) doctors were discarding glove correctly. More than 85% of participants were discarding needles, soiled dressings and intravenous infusion sets appropriately. Only 23.2% (n=16) nurses and 27.39% (n=20) doctors had noticed label details on biomedical waste bags. Correct waste bag filling proportion was found only in 43.5% (n=30) nurses. Sub-

stantially 79.5% (n=167) participants answered that biomedical waste transport practice was proper in the institute. Predominantly 79% (n=166) participants were practicing disposal of pretreated waste without mixing with municipal waste. Only 40.6% (n=28) nurses and 42.46% (n=31) doctors were practicing correct method of preparation of 1% sodium hypochlorite from the 5% strength. Appropriate blood spillage management practices were found only in 43.5% (n=30) nurses. (Table 4)

We found that knowledge, attitude and practice scores of laboratory technicians were highest. The knowledge and practice scores of resident doctors (72.49% and 61.9%) were significantly higher than those of nurses. (Table 5)

Technicians with more than 10 years of experience performed better than those with less than 10 years of experience. In contrast, nurses with less than 10 years of experience outperformed nurses with more than 10 years of experience in knowledge and practice of biomedical waste management. First year resident doctors (71.72%) showed higher score in attitude compared to senior resident doctors (69.25%). However, knowledge and practice scores of senior resident doctors (74.35% and 63.1%) were higher than first year resident doctors (69.45% and 60%). (Table 6)

Trained health care workers mean scores were higher compared to untrained ones in attitude and practices regarding biomedical waste management and bio-safety. Knowledge scores were better in untrained health care professionals than the trained ones. (Table 7)

DISCUSSION

Healthcare sector generates huge amount of biomedical waste which carries high potential of infection and injury than any other type of waste. It is estimated that 10-25% of healthcare waste is infectious in nature.⁸ For an effective waste management waste should be managed at every step from collection to disposal.⁹ Every concerned health worker is expected to have proper knowledge, attitude and practice for biomedical waste management. Hence, the present study was conducted to assess current knowledge, attitude and practice of biomedical waste management among healthcare workers in tertiary care hospital and to fill the gaps with future training programs.

Most of the participants were aware about the biomedical waste management rules 1998, objectives of biomedical waste management, risk associated with waste handling and biohazard symbol. This awareness is better than the observations of other studies done in India by Sood et al, Sanjeev et al, Naresh et al and Das SK et al.⁹⁻¹¹ However, much better awareness among healthcare workers were found in Soyam GC et al, Bakshi R et al and Kulkarni VL et al.¹³⁻¹⁵ Recognition of biohazard symbol is poorer in study done by Sanjeev et al.¹⁰ This awareness about biomedical waste management can be attributed to frequent biomedical waste training programs and poster campaigns in the past. However better recognition is found in study done by Bakshi R et al.¹⁴ So, more emphasis can be given on biohazard symbol identification in future training programs as well as various educational material display.

Study done by Das SK et al has shown 37.41% of healthcare workers were aware about hazards of biomedical waste. High awareness among healthcare workers (98%) about hazards and dangers of biomedical waste in present study is comparable to study done by Naresh et al.¹¹ Such a high awareness among healthcare workers can be used to develop a positive attitude and correct practices towards safe and effective biomedical waste management. Correct knowledge about amount of general waste and hazardous waste generated by healthcare activities in hospital is with 64.28% of healthcare workers. Such awareness is much higher compared to study done by Pullishery F et al (46%).¹⁶

An important pre-requisite and key step for successful biomedical waste management is segregation of the waste at the point of generation into color coded bags and bins. This is not known to many of the participants especially nurses. This is very low compared to study done by Soyam GC et al.¹³ Nurses were also not aware about which bags/bins need pretreatment. So the future training programs must focus on these segregation and pretreatment especially in the nursing staff. The untreated biomedical waste cannot be stored beyond 48 hours without approval from the authority.

Correct knowledge regarding the maximum time limit for biomedical waste storage was not found in the participants especially again in nurses. Study done by Sanjeev et al showed better awareness in about 60% of the participants.¹⁰ However finding is not as bad as study done by SK Das et al which showed that only 7% of healthcare workers were aware about it.¹² Storage of biomedical waste should be emphasized in future training programs. Detailed discussion should be done when one can keep biomedical waste for more than 48 hours, procedure for approval from authority and various treatment options for waste.

The participants were aware who to report in case of needle stick injury, but were not aware when to take Post exposure prophylaxis especially. An awareness campaign is must for post-exposure prophylaxis in the participants to ensure their safety in case of needle-stick injuries.

The participants had positive attitude towards biomedical waste management rules and its implementation. This is comparable to study done by Soyam GC et al.¹³ They believed in team work and wanted strict implementation of biomedical waste rules. All the healthcare workers in study done by Naresh et al and Malini et were agreed upon that biomedical waste management is team work.^{11,17} However, 67% participants think that biomedical waste management is a financial burden to the hospital, which is comparable to study done by Kulkarni et al.¹⁵

Though more than 50% of the participants had received training in biomedical waste management, almost all of them wanted regular training programmes to enhance and upgrade their knowledge regarding the topic. Similar finding was noted in study done by Naresh et al and Malini et al.^{11,17} However, it better than study conducted by Sanjeev et al.⁹ We conduct training programs once a year for technicians, nursing staffs and resident doctors emphasizing on biomedical waste management and bio-safety. This study has also made us realize that biomedical waste management training programs should be conducted more fre-

quently to include untrained technicians, nurses and resident doctors.

Practices were lacking in segregation at point of generation and use of correct color coded bins for it, especially in nurses. This result is better than results of Sanjeev et al and Sudhakar et al^{8,9}. It is strikingly in contrast with the result of studies done by Naresh et al, Charania ZK et al in Chennai and Sudhir KM et al in Davangere where the corresponding figures were 63.03%, 82.4% and 70% respectively.^{11,18-19} Practices for disposal of needles, soiled dressings and intravenous infusion sets were appropriate in most of the participants. Doctors needed more training for correct disposal of used gloves. Waste bag filling and labeling and sodium hypochlorite preparation practices needed more improvement in nurses and doctors. Blood spillage practices should be implemented correctly by nurses.

Though the vaccination results of participants are better than those found in study done by Malini A et al, an active effort is still needed to cover remaining unvaccinated healthcare workers.¹⁷ Efficacy of Hepatitis B vaccination should be evaluated by measuring Anti-HBs titres in vaccinated healthcare workers.

In the current study it was found that knowledge and practice regarding biomedical waste management and bio-safety was better among technicians and doctors than nurses. A study done by Mathew et al, Ludhiana showed the same result.²⁰ Study done by S A Hakim et al showed the opposite findings that the practice scores of nurses (84.8%) were significantly higher than those of doctors (67.3%).³ In study done by Madhukumar S et al in Bangalore it was found that nurses practiced biomedical waste management significantly better than technician staff.²¹ The results undoubtedly reflect nurses' lack of awareness of the problem in general and their role in waste management in particular. This may be attributable to their lack of training and educational qualification. Another reason for deficient practices might be patient overload as the hospital provides most of the healthcare services free of cost to the public. Inadequate supplies of resources and manpower might also contribute to deficient practices. Experienced technicians and doctors outperformed their newly recruited counterparts. These findings suggest that more experience in healthcare field would create more awareness about biomedical waste management and allow them to practice it correctly. Training senior healthcare staff will have dual advantage, one to refresh and update their existing knowledge and second being that they will train their junior staff. In contrast, nurses with less than 10 years of experience performed better than the

ones with more than 10 years of experience. This also should be noted while creating a schedule for training of biomedical waste management programs.

It is also evident from our study that trained health care professionals have better attitude and practices towards biomedical waste management and bio-safety compared to untrained ones. Interestingly, untrained health care workers scored more in knowledge as their curriculum memory are still fresh. So, future training programs should focus on refreshing knowledge aspect in experienced and trained health care professionals. Attitude and practical demonstrations should be of focus in untrained health care workers.

The limitation of our study was that we could not assess every aspect of KAP as it was based on multiple choice questions questionnaire. More details on problems faced by healthcare workers and their suggestions could not be obtained by this format.

CONCLUSION

There is a need for intensive training programs at regular intervals to re-train all the staff with special focus on nurses and first year resident doctors. Strict supervision and surveillance should be followed daily regarding hospital waste management activities.

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REFERENCES

1. Biomedical Waste (management and handling) Rules 1998, 2000, Ministry of Environment and Forests Notification, New Delhi
2. Pasupathi P, Sindhu SR, Ponnusha BS, Ambika A. Biomedical waste management for health care industry. *Int J Biol Med Res* 2011;2:472-86.
3. S.A.Hakim, A.Mohsen and I. Bakr Knowledge, attitudes and practices of health-care personnel towards waste disposal management at Ain Shams University Hospitals, Cairo. *Eastern Mediterranean Journal*, 2014, vol 20: No. 5
4. Safe management of waste from health care activities. WHO, Geneva; 1999.
5. Sood AG, Sood A. Dental perspective on biomedical waste and mercury management: A knowledge, attitude and practice survey. *Ind J Dent Res* 2011; 22:371-5
6. Ostwal.K, Jadhav.A, More.S, Shah.P, Shaikh.N. Knowledge, attitude and practice assessment of biomedical waste management in tertiary care hospital: It's high time to train ourselves. *International journal of environmental sciences* Volume 5, No 6, 2015, PP 1115-1121

7. Kulkarni VL, Rajhans VV, More SR, Nilekar SL, Kulkarni DM, Ovhal RS, Halgarkar CS, Sagar KB, Abdagire NV, Tathe SS. A Comparative Study of Knowledge, Attitude and Practice Regarding Biomedical Waste Management Before and After Training among Doctors. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)* Volume 15, Issue 4 Ver. VIII (Apr. 2016), PP 50-54
8. Govt of India. Biomedical waste (Management and Handling) Rules, 1998. Extraordinary, part II, Section 3, Subsection (ii). The Gazette of India 1998, 27 Jul; No. 460
9. Sanjeev R, Suneesh Kuruvilla, Subramaniam R, Prashant PS, Meera Gopalakrishnan. Knowledge, attitude and practices about biomedical waste management among dental health-care personnel in dental colleges in Kothamangalam: a cross sectional study. *Health sciences* 2014; 1 (3): JS0011
10. Sudhakar V, Chandrashekhar J. Dental health care waste disposal among private dental practices in Bangalore city, India. *Int Dent J* 2008; 58: 51-54
11. Naresh Kumar Munda , Vivek Kashyap , Shamim Haider , Vidya Sagar. To Study the Knowledge, Attitude and Practices of Staffs at several levels on Biomedical waste Management at RIMS Ranchi: Hospital Based Cross-Sectional Study. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)* Volume 14, Issue 12 Ver. I (Dec. 2015), PP 86-89
12. Das SK, Biswas R. Awareness and practice of biomedical waste management among healthcare providers in a Tertiary Care Hospital of West Bengal, India. *Int J Med Public Health* 2016;6:19-25.
13. Soyam GC, Hiwarkar PA, Kawalkar UG, Soyam VC, Gupta VK. KAP study of bio-medical waste management among health care workers in Delhi. *Int J Community Med Public Health* 2017;4:3332-7.
14. Bakshi R, Ghosh N, Mukherjee R, Chakraborty S. Assessment of Knowledge and practice of biomedical waste management among health care personnel in a rural tertiary care hospital of Darjeeling District, West Bengal, India. *Journal of comprehensive health*, 2018; 6 (1), 14-18.
15. Kulkarni VL, Rajhans VV, More SR, Nilekar SL, Kulkarni DM, Ovhal RS, Halgarkar CS, Sagar KB, Abdagire NV, Tathe SS. A Comparative Study of Knowledge, Attitude and Practice Regarding Biomedical Waste Management Before and After Training among Doctors. *OSR Journal of Dental and Medical Sciences (IOSR-JDMS)*. Volume 15, Issue 4 Ver. VIII (Apr. 2016), PP 50-54
16. Pullishery F, Panchmal GS, Siddique S, Abraham A. Awareness, Knowledge and Practices on Bio-Medical Waste Management Among Health Care Professionals in Mangalore- A Cross Sectional Study. *IAIM*, 2016; 3 (1): 29-35.
17. Malini A et al. Knowledge, attitude and practice of Biomedical waste management among health care personnel in a tertiary care hospital in Puducherry. *International Journal of Biomedical Research* 2015; 6 (03): 172-176
18. Charania ZK, Ingle NA. Awareness and practices of dental care waste management among dental practitioners in Chennai city. *Journal of Contemporary Dentistry* 2011;1:1
19. Sudhir KM, et al. Awareness and practices about dental health care waste management among dentists of Davangere city, Karnataka. *Journal of Indian Association of Public Health Dentistry* 2006;8:44-50
20. Mathew SS, Benjamin AI, Sengupta P. Assessment of biomedical waste management practices in a tertiary care teaching hospital in Ludhiana. *Healthline*, 2011, 2:28-30.
21. Madhukumar S, Ramesh G. Study about awareness and practices about health care waste management among hospital staff in a medical college hospital, Bangalore. *Iranian Journal of Basic Medical Sciences*, 2012, 3:7-11.