

## AWARENESS ON BIOMEDICAL WASTE MANAGEMENT AND NEEDLE STICK INJURY AMONG HEALTH CARE WORKERS IN A TERTIARY CARE HOSPITAL

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### Abstract

**Background:** Bio-medical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or else in the production or testing of biological and also wastes that are generated in health camps. It includes all the waste generated from the Health Care Facility having adverse effects on the health of a person or to the environment in general as per BMW rules 2016(3,4). Needle stick injury (NSI) is a significant occupational hazard in hospitals, as it is capable of transmitting blood borne viruses like Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human immunodeficiency virus (HIV). It is found that approximately, three million healthcare workers (HCWs) are exposed to these blood borne infections annually. **Materials& methods:** A descriptive study was conducted to assess the awareness regarding biomedical waste management and needle stick injury among healthcare workers. Their Knowledge, Attitude, Practice (KAP) regarding biomedical waste management and Needle Stick Injury with its prevention and also their adherence to relevant regulations and safety practices was assessed using pre-designed, multi-partite, open and closed-ended questionnaires. **Results:** From the study, it is identified that the knowledge regarding BMW and NSIs with its prevention need to be improved further among the healthcare professionals. **Conclusion:** To have a betterment, there should be adequate training among the HCWs about BMW and NSIs and its preventions like video lectures, symposiums, quiz programs, and role play that can help them update their knowledge, attitude and practices.

## INTRODUCTION

Bio-medical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or else in the production or testing of biological and also the wastes that are generated in health camps.<sup>[1,2]</sup> It includes all the waste generated from the Health Care Facility which has adverse effects on the health of a person or to the environment in general as per Biomedical waste management rules 2016.(BMW rules 2016).<sup>[3,4]</sup>

The Biomedical waste generation, storage, transport, proper disposal, and treatment rules apply to all the setups in the health care facilities which include hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological

laboratories, blood banks, Ayush hospitals, clinics, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first aid rooms of schools, forensic laboratories and research laboratories.<sup>[4]</sup>

According to WHO 2009, the quantum of biomedical waste generated in India is estimated to be 1 to 2 kg/bed/day in a hospital and 600 gm/bed/day in a general practitioner clinic. If the Common Biomedical Treatment Facility Centre (CBMWTF) is available within a 75 km radius from the health care facility (HCF), biomedical waste should be treated and disposed of through the CBMWTF operator.

The quantity of biomedical waste generated from the healthcare facility is around 10% to 15%. This waste includes the materials that are in contact with the patient's blood, secretions, infected parts, biological

Liquids such as chemicals, medical supplies, medicines, lab discharge, sharps metallic and glassware, plastics, etc. [5]. As of now, it is essential that doctors, CRMI doctors, staff nurses, lab technicians and other hospital workers should understand the importance of biomedical waste segregation and become aware of the impact on the improper management of biomedical waste and its hazards among the health care personnel.<sup>[6]</sup>

Needle stick injury (NSI) is also a significant occupational hazard in hospitals, as it is capable of transmitting blood borne viruses like Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human immunodeficiency virus (HIV). It is found that approximately, three million healthcare workers (HCWs) are exposed to these blood borne infections annually. Needle stick injuries occur when needles contaminated with pathogens were used or when blood from infected patients come into contact with the mucous membranes of the eyes, nose, or mouth.<sup>[7,8]</sup>

The prevalence of NSIs in the hospital risks HCWs' safety and impacts patient care quality. Most of the healthcare workers working in operating rooms, delivery rooms, emergency departments, and laboratories were at higher risk of developing needle stick injuries.<sup>[9]</sup> However, despite adequate knowledge, they often fail to meet the indicators due to inadequate practice of Universal Precautions (UP) which includes using gloves, goggles, and other protective gear while handling specimens or collecting blood and bodily fluids.<sup>[10,11]</sup>

Thus, the present study aimed to assess the awareness, knowledge, attitude, and practices in the management of BMW and needle stick injury and its prevention among the health care personnel with the help of open and close-ended questionnaires. Open-ended questionnaires are questions that cannot be answered with a simple "Yes or No" and instead require the respondent to elaborate on their points. Closed-ended questionnaires are the questions that form pre-defined responses such as "Yes or No".<sup>[12]</sup>

## MATERIALS AND METHODS

This cross-sectional descriptive study was conducted to assess the awareness regarding biomedical waste management and needle stick injury (investigate healthcare workers Knowledge, Attitude, Practice regarding Biomedical waste management and Needle Stick Injury) in Tertiary Care Hospital, Government Medical College and ESI Hospital, Coimbatore, Tamil Nadu from August to December 2023.

The Study was initiated after getting approval from the Ethical committee of Government Medical College and ESI Hospital, Coimbatore. The sample size was calculated statistically based on knowledge (p1) 64% on biomedical waste management as per the previous researches done, considering a 95 % confidence interval, precision of 10% and 10% non-response rate. As per the above calculation the exact sample size is 267. Those who gave willingness to be

a part of the study were also included so that the sample size reached 300. Those who did not give consent were considered as exclusion criteria. It is important to note that all participants (100%) had received in-service training on biomedical waste management and needle stick injury prior to the study.<sup>[13]</sup>

Healthcare workers including Doctors, CRMI's, Nurses, lab technicians, and other Healthcare workers (cleaning staff) who attended the Biomedical Waste Management training and were willing to participate in the study were assessed by random sampling. A pre-designed, multi-partite, open and closed-ended questionnaire with a fixed structure was utilized to assess participants' knowledge, attitude, and practice of BMW and NSIs, serving to evaluate their understanding, attitudes, and adherence to relevant regulations and safety practices.

The information was composed by means of a pre-designed, open and closed-ended questionnaire by reviewing the Biomedical Waste Management Guidelines, 2016 and the amendments to Biomedical Waste Management Guidelines, 2019.

The questions were divided into 5 sections. The first section collected data about the socio demographic variables of study subjects. The second section consisted of questions to obtain information regarding knowledge and awareness pertaining to biomedical waste management. The third section consisted of questions assessing the practical aspects of biomedical waste management. The fourth section included questions to assess the attitude of health care workers pertaining to biomedical waste management practices. The fifth section included questions to obtain information with respect to awareness on the preventive measures to be taken before and after needle stick injury.

Oral informed consent was obtained from all the study subjects. Confidentiality and anonymity of information collected from the study subjects were maintained. Participants who did not give consent were not included in the study. The demographic variables such as age, gender, category of health care workers, and nature of employment were included. The knowledge and awareness questionnaire consisted of 10 questions. Answers were recorded from the options in which one option was the correct response with 4 options given for each question.

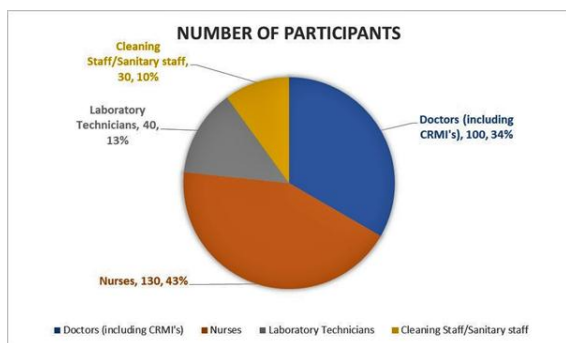
The practical aspects of biomedical waste management section consisted of 10 questions in which one out of four options was the correct response. The attitude of health care workers pertaining to Biomedical waste management practices checklist consisted of 10 questions and responses were recorded in terms of yes or no and either True or False.

The overall mean of knowledge and awareness score was calculated. For "knowledge and awareness", participants' average scores were categorized as excellent (>90%), good (70-90%), satisfactory (50-70%), or needs improvement (<50%). Similarly for the practical aspects of the biomedical waste

management section, needle stick injuries and the attitude of health care workers about biomedical waste management practices checklist is categorized. The Needle Stick Injury (NSI) Questionnaire assessed healthcare workers' knowledge, attitude, and practices regarding needle stick injuries, a potential occupational hazard in healthcare settings. The ten questions probed participants' ideas on Needle Stick Injury (NSI). In the questionnaire, 7 were multiple-choice questions (single correct answer from 4 options), 2 were questions with yes/no options, and 1 question with true or false options. Question 10, about Hepatitis B vaccination, offered three different response options ("Yes," "No," and "Yet to complete 3 doses"). These questionnaires allowed for a more detailed understanding of participants' vaccination status and an option to capture partial immunization status. Participants' overall scores were categorized based on their average as Excellent response showing more than 90% (indicating thorough knowledge and understanding), Good response showing 70-90% (suggesting a strong grasp of key concepts), Satisfactory response showing 50-70% (demonstrating basic knowledge and awareness) and Needs Improvement response is <50% (highlighting areas requiring further reinforcement). Statistical analysis was done. The Results data were expressed in form of percentages and frequencies for all categories. The results were evaluated and then the conclusion was arrived.

## RESULTS

This descriptive cross sectional study aimed to analyze the knowledge, attitude and practices (KAP) about biomedical waste management and Needle stick injury among healthcare workers in a tertiary care hospital. The health care workers includes all category people like doctors which include CRMI doctors, staff nurses, lab technicians and sanitary staffs. The study was conducted for a period of 5 months from August to December 2023 in the Government Medical college and ESI hospital, Coimbatore.



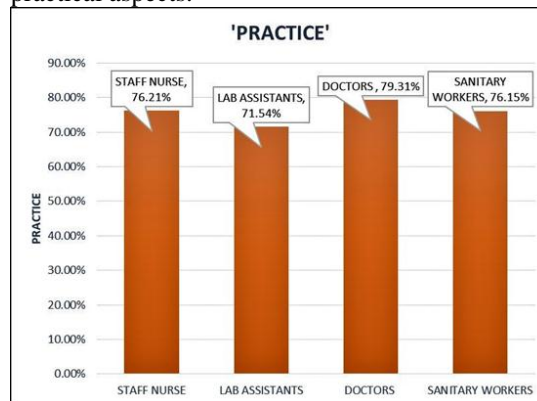
**Figure 1: Socio demographic variables of the study population**

The participant's knowledge, attitude, and practice (KAP) regarding both biomedical waste management (BMWM) and needle stick injuries (NSIs) were assessed through pre-designed, multi-part questionnaire with a fixed, closed-ended structure. Among 300 healthcare workers, 43% were nurses, 34% were doctors including internship CRMIs, 13% were lab assistants and 10% were sanitary staff involved in the study after getting informed consent from them which is illustrated in [Figure 1].

The descriptive study included close-ended questions which were divided into 5 sections. The first section gives details about the socio-demographic variables of study subjects. According to [Table 1], Out of 300 study participants, 50.66% of them were between 18 to 30 years of age, 33% of them were between 31-40 years, 11% were between 41- 50 years and around 5.33% were between 51- 60 years of age.

According to [Table 2], the second section has 10 questions to obtain information regarding knowledge and awareness about biomedical waste management is included. In our study, among 300 participants, 65.20% of doctors had a good knowledge and awareness about biomedical waste management. Likewise, 53.31% of staff nurses, 61% of lab technicians, and 57% of sanitary staff also showed good knowledge and awareness of Biomedical Waste management. Further sessions in the biomedical waste management awareness programs will be useful in developing their knowledge and awareness of the same.

The third section consisted of 13 questions assessing the practical aspects of biomedical waste management. In our study, among 300 participants, 79.31% of doctors had a good knowledge of the practical aspects of biomedical waste disposal. On the evaluation of other staff in hospitals, 76.21% of staff nurses, 71.54% of lab technicians, and 76.15% of sanitary staff also showed good knowledge of the proper segregation of biomedical waste into respective color-coded bins, and all the sanitary staff were also trained in proper segregation of wastes. This is very well illustrated in Figure 2. Proper and regular training on the disposal of biomedical waste management will further improve their knowledge of practical aspects.



**Figure 2: practical assessment of BMW among different participants**

According to [Table 3], the fourth section included 10 questions to assess the attitude of health care workers pertaining to biomedical waste management practices. In our study, among 300 participants, 86.6% of doctors were good in the practices on segregation of biomedical wastes. On assessing the knowledge of the other staffs, 85.23% of staff nurses, 84.25% of lab technicians and 86.33% of sanitary staffs had a good practical attitude on the proper segregation of biomedical waste in to respective color coded bins and in understanding the Information, Education and Communication (IEC) materials that are displayed. For further improvement in the segregation of waste in the hospital settings, BMW trainings at regular intervals to be conducted so that thorough knowledge over the practices of disposal will be attained.

The fifth section included 10 questions to obtain information concerning awareness of the preventive measures to be taken before and after needle stick injury. In our study, among 300 participants, 84% of doctors had a basic knowledge on the preventive

measures behind the needle stick injury. On evaluation of other staffs in hospitals, 82.54% of staff nurses, 81% of lab technicians and 83.67% of sanitary staffs also showed good knowledge on the preventive measures on the needle stick injury. This is illustrated in figure 3. Proper and regular training on the needle stick injury, its complication and its preventive way management will further improve their knowledge on practical aspects.

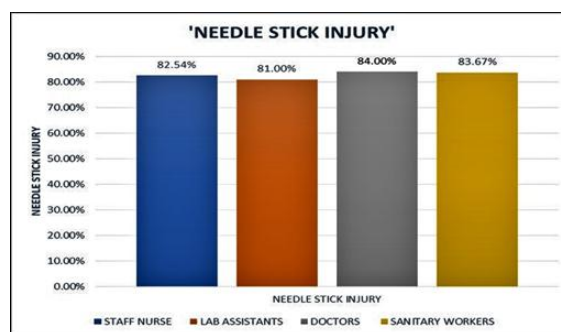


Figure 3: knowledge of participants on Needle stick injury

Table 1: Socio demographic variables (Age)

Age	Number of participants	Percentage
18-30	152	50
31-40	99	33
41-50	33	11
51-60	16	5.33

Table 2: BMW knowledge and awareness

Parameters	Staff Nurse N=130	Doctors N=100	Lab Assistants N=40	Cleaning/sanitary Staff N=30
1. Which of the following best defines biomedical waste? a. Waste generated during agricultural activities. b. Waste generated during diagnosis, treatment or immunization of human beings or animals. c. Waste generated during industrial production activities. d. Waste generated during housekeeping activities.	114/ 87.69%	98/ 98.00%	38/ 95.00%	30/ 100.00%
2. Which of the following authority is responsible for Biomedical Waste Management? a. State Pollution Control Board b. Central Pollution Control Board c. Hospital Management d. Common Bio-Medical Waste Management Facility	6/ 4.62%	6/ 6.00%	3/ 7.50%	0/ 0.00%
3. Why is segregation and pre-treatment of waste necessary before it is collected by the CBWTF Operator? a. To reduce the volume of waste b. To reduce the weight of waste c. To reduce the cost of transportation d. To reduce the environment hazard & risk of infection to those handling the waste	127/ 97.69%	91/ 91.00%	37/ 92.50%	25/ 83.33%
4. Healthcare waste management guidelines were given in the year a. 2010 b. 2012 c. 2014 d. 2016	91/ 70.00%	80 80.00%	29/ 72.50%	20/ 66.67%
5. Amendments to Biomedical waste management rules were made in the year. a. 2019 b. 2022 c. 2020 d. 2021	93/ 71.54%	79/ 79.00%	30/ 75.00%	15/ 50.00%
6. What is the maximum storage time allowed for healthcare waste before it is transported to a Common Biomedical Waste Treatment Facility? a. 24 hours	40/ 30.77%	65/ 65.00%	26/ 65.00%	15/ 50.00%

b.48 hours c.72 hours d.96 hours				
7. What is the percentage range of healthcare waste generated from a healthcare facility? a.5% to 10% b. 10% to 15% c. 15% to 20% d. 20% to 25%	59/ 45.38%	63/ 63.00%	16/ 40.00%	22/ 73.33%
8. What is the penalty for non-compliance with the Biomedical Waste Management Rules? a. 10,000 b. 1 lakh c. 2 lakhs d. 5 lakhs	86/ 66.15%	81/ 81.00%	33/ 82.50%	21/ 70.00%
9. Every healthcare facility needs to maintain records on ___ (I) ___basis, Update information in website (category wise) on ___ (II) ___basis and retain the records on handling of biomedical waste for a period of ___ (III) ___ years. a. (I) weekly, (II)monthly, (III) two b. (I) monthly, (II) yearly, (III) yearly c. (I) daily, (II) monthly, (III) five d. (I) daily, (II) weekly, (III) yearly	52/ 40.00%	55/ 55.00%	22/ 55.00%	18/ 60.00%
10. Concentration of hypochlorite that must be used for chemical disinfection is a. 0.5%-2% b. 2%-10% c. 5%-10% d. 1%-2%	25/ 19.23%	34/ 34.00%	10/ 25.00%	5/ 16.67%
AVERAGE	53.31%	65.20%	61.00%	57.00%

**Table 3: Practices assessment on BMW.**

Parameters	Staff Nurse N=140	Doctors N=100	Lab Assistants N=40	Cleaning Staff N=30
1. Do you feel it is important /necessary to have Effluent Treatment Plant in our Hospital? a. Yes b. No	127/ 97.69%	97/ 97.00%	40/ 100.00%	30/ 100.00%
2. Is it important for chemical disinfection to be performed? a. Yes b. No	125/ 96.15%	99/ 99.00%	38/ 95.00%	29/ 96.67%
3. Bio-Medical Waste Management is a teamwork. a. True b. False	130/ 100.00%	99/ 99.00%	40/ 100.00%	30/ 100.00%
4. Color coding is necessary at the point of generation. a. True b. False	130/ 100.00%	98/ 98.00%	38/ 95.00%	30/ 100.00%
5. Do color-coded waste bags and containers need to be printed with the bio-hazard symbol? a. yes b. No	126/ 96.92%	96/ 96.00%	38/ 95.00%	29/ 96.67%
6. Is it necessary to label the waste bags and containers with details such as date, type of waste, and waste quantity? a. yes b. No	123/ 94.62%	93/ 93.00%	38/ 95.00%	28/ 93.33%
7. Is it necessary to use PPE while handling Bio-Medical Waste/Mercury Spill a. Yes b. No	126/ 96.92%	97/ 97.00%	39/ 97.50%	29/ 96.67%
8. Are public healthcare facilities within 75 kilometres of a CBWTF allowed to establish their own treatment and disposal facility for biomedical waste? a. Yes b. No	29/ 22.31%	29/ 29.00%	6/ 15.00%	9/ 30.00%
9. Is a weighing machine as per the specifications given in CPCB (Central Pollution Control Board) guidelines needs to be kept in central waste collection area in the health care facility? a. Yes b. No	123/ 94.62%	95/ 95.00%	40/ 100.00%	28/ 93.33%
10. Can chlorinated plastic bags be used for waste collection? a. Yes b. No	69/ 53.08%	63/ 63.00%	20/ 50.00%	17/ 56.67%

AVERAGE	85.23%	86.60%	84.25%	86.33%
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## DISCUSSION

Biomedical waste segregation plays an utmost importance in every hospital setting. According to BMW management rules 2016, 85% of the waste is non-infectious and 15% is infectious waste. So proper collection, segregation, and disposal of the waste to common biomedical waste treatment facilities plays a vital role. Hospital infection control committee staff nurses look after all operation theatres, ICUs, and wards for their appropriate disposal daily and they report it to the infection control nodal officer. To increase the quality of biomedical waste management IEC (Information, Education Communication) materials are to be displayed in every area of the hospital where the wastes are generated and color-coded bags are used for proper segregation and disposal. Regular training for all the doctors, staff, technicians, and hospital workers is to be conducted to improve the quality of biomedical waste management.<sup>[14]</sup>

In our study, 81% of the participants were females and 19% were males when compared to study by Bansal et al where 52% of the participants were men and 48% were women.<sup>[14]</sup> Among the HCWs, 65.2% of doctors, had a knowledge on the definition of BMW management and the amendment done in 2019 when compared to study by G.Bhagwathi et al where only 47% of them had knowledge regarding the definition of BMW, 36.9% awareness in desmukh et al and only 4.7% awareness as per Kahn et al.<sup>[15-18]</sup>

In our study, 76.21% and 76.15% of the staff nurses and sanitary staff have satisfactory knowledge of the practices of biomedical waste management and the segregation of waste into appropriate color-coded bins when compared to the study by Madhan Kumar et al and Mathew et al where the practice of segregation of biomedical waste among the staff nurse and sanitary staff were 62.5% and 100% respectively.<sup>[19,20]</sup> Adequate training programs at regular intervals will be appropriate to improve the practices of biomedical waste management.

The knowledge about common biomedical waste disposal treatment facility (CBMWTF) initiated by Government of India for BMWM was less satisfactory when compared to other studies. In our study, 91% of doctors, 97.69% of nurses and 92.5% of lab technicians were aware of the treatment facility centre and the knowledge of the doctors is quiet less when compared to other hospital staffs. This might be due to the majority of doctors who participated in the study were newly joined in internship. In study by Narang et al 85.4% doctors, 73.7% nurses and 71.4% technicians are aware of treatment facility centre that is available.<sup>[21]</sup>

In our study, the knowledge and practical skills over needle stick injury are 84% among doctors, 83.57% among health care workers, 82.54% among staff nurses, and 81.67% among technicians when compared to the study done by Palaneswamy et al,

where the awareness over needle stick injury and its prevention among staff nurses is 47.3% followed by doctors where the awareness is 28.94%.<sup>[22,23]</sup> Needle stick injury is one of the significant occupational hazards to healthcare workers with a risk of developing blood-borne infections. The development of effective training programs for all health care workers so that they have adequate knowledge on needle stick injuries and their way of prevention.<sup>[24]</sup>

## CONCLUSION

The impact of improper biomedical waste management leads to various problems like air and soil pollution if not treated properly, radioactive pollution due to radioactive isotopes for diagnostic and therapeutic applications, operational health hazard due to improper handling of sharps and finally it aggravates the problem of antimicrobial resistance (AMR). So the knowledge, attitude and practices of biomedical waste management plays a vital role.

From the study, it is identified that the knowledge regarding BMWM and needle stick injuries with its prevention need to be improved further among the healthcare professionals. To have a betterment, there should be adequate training among the HCWs about BMWM and needle stick injury preventions like video lectures, symposiums, quiz programs, and role play that can help them update their knowledge, attitude and practices.

## REFERENCES

1. Pandey, Anita, Sanjiv Ahuja, Molly Madan, and Ajay Kumar Asthana. "Bio-medical waste management in a tertiary care hospital: an overview." *Journal of clinical and diagnostic research: JCDR* 10, no. 11 (2016): DC01.
2. Razdan, Prithi, and Amerjeet Singh Cheema. "Bio-medical waste management system." ASCNT, CDAC, Noida, India (2009): 26-31.
3. Khajuria, A., and A. Kumar. "Assessment of healthcare waste generated by Government Hospital in Agra city, India." *Our Nature* 5, no. 1 (2007): 25-30.
4. Sharma, Madhuri. *Hospital waste management and its monitoring*. Jaypee brother's publishers, 2002.
5. Boss, U. J. C., G. Poyyamoli, and Gautam Roy Gautam Roy. "Evaluation of biomedical waste management in the primary and community health centers in Puducherry region, India." (2013): 592-604.
6. Mayta-Tovalino, Frank, Arnaldo Munive-Degregori, Rocío Bocanegra, Roman Mendoza, Juan Alvitex, and Abigail Temoche. "Awareness, Knowledge, Attitude, and Practices in the Management of Biomedical Waste: A Multivariate Analysis of Associated Factors in Peruvian Students." *World* 13, no. 1 (2022):
7. Kebede, Awoke, and Hadgu Gerensea. "Prevalence of needle stick injury and its associated factors among nurses working in public hospitals of Dessie town, Northeast Ethiopia, 2016." *BMC research notes* 11 (2018): 1-6.
8. Kutubudin, Ahmed Farrasyah Mohd, Mohd Nazri Shafei, Mohd Ismail Ibrahim, and Najib Majdi Yaacob. "Development and Validation of the Needle stick Injury Prevention (N-SIP) Module." *Cureus* 16, no. 7 (2024).
9. Amira, C. O., and J. O. Awobusuyi. "Needle-stick injury among health care workers in hemodialysis units in Nigeria: a

- multi-center study." *The International Journal of Occupational and Environmental Medicine* 5, no. 1 (2014): 1.
10. Lee, Lai Kah, and Ismail Noor Hassim. "Implication of the prevalence of needle stick injuries in a general hospital in Malaysia and its risk in clinical practice." *Environmental health and preventive medicine* 10, no. 1 (2005): 33-41.
  11. Thakur, Aditya, Manju Toppo, and D. K. Pal. "Occupational exposure to needle stick and sharp injuries among hospital waste handlers in selected government health facilities of Bhopal district." *Int J Health Sci Res* 5, no. 5 (2015): 37-43.
  12. Sharma, Alok, Varsha Sharma, Swati Sharma, and Prabhat Singh. "Awareness of biomedical waste management among health care personnel in Jaipur, India." *Oral Health Dent Manag* 12, no. 1 (2013): 32-40.
  13. Gupta, V., D. Mohapatra, and V. Kumar. "Study to assess the knowledge, attitude and practices of biomedical waste management among health care personnel at tertiary care hospital in Haryana." *Int J Basic Appl Med Sci* 5, no. 2 (2015): 102-107.
  14. Saikerthana, D., P. Prabha, V. Vijayashree, and Gogula NM Krishna. "Overview of Pathogens causing Nosocomial Infections in Various Wards of a Tertiary Health Care Hospital and their Antimicrobial Susceptibility Pattern-A Prospective Surveillance Study." *Journal of Pure & Applied Microbiology* 15, no. 4 (2021).
  15. Bansal, Mohit, Shelja Vashisth, and Nidhi Gupta. "Knowledge, Awareness and Practices of dental care waste management among private dental practitioners in Tricity (Chandigarh, Panchkula and Mohali)." *Journal of International Society of Preventive and Community Dentistry* 3, no. 2 (2013): 72-76.
  16. Bhagawati, G., S. Nandwani, and S. Singhal. "Awareness and practices regarding bio-medical waste management among health care workers in a tertiary care hospital in Delhi." *Indian journal of medical microbiology* 33, no. 4 (2015): 580-582.
  17. Deshmukh, Jyotsna S., Namita N. Deshmukh, and Mamta K. Shewte. "Biomedical waste management and nosocomial infections: Knowledge, attitudes and practices in a tertiary care hospital." *Journal of Academia and Industrial Research (JAIR)* 2, no. 7 (2013): 426.
  18. Kahn, P. S., and G. Raviprabhu. "Knowledge about biomedical waste management among medical students of a tertiary care hospital, Tirupati." *Int J Res Health Sci* 1, no. 2 (2013).
  19. Madhukumar, Suwaran, and G. Ramesh. "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* 3, no. 1 (2012): 7-11.
  20. Mathew, Savan Sara, A. I. Benjamin, and Paramita Sengupta. "Assessment of biomedical waste management practices in a tertiary care teaching hospital in Ludhiana." *Healthline* 2, no. 2 (2011): 28-30.
  21. Narang, Ramandeep S., Adesh Manchanda, Simarpreet Singh, Nitin Verma, and Sarfaraz Padda. "Awareness of biomedical waste management among dental professionals and auxiliary staff in Amritsar, India." *Oral Health Dent Manag* 11, no. 4 (2012): 162-8.
  22. Palaneswamy Savetha, Akshada Srikumar, Iyanar Kannan, and Thenmozhivalli Pitchai Rathinam. "Assessment of knowledge, attitude, and practices of biomedical waste management among health care workers in a tertiary care hospital, Chengalpattu, Tamilnadu, India." *International Journal of Occupational Safety and Health* 14, no. 1 (2024): 124-133.
  23. Kumar, Rajiv, Anil Kumar Gupta, Arun Kumar Aggarwal, and Ashok Kumar. "A descriptive study on evaluation of biomedical waste management in a tertiary care public hospital of North India." *Journal of Environmental Health Science and Engineering* 12 (2014): 1-7.
  24. Thakur, Aditya, Manju Toppo, and D. K. Pal. "Occupational exposure to needle stick and sharp injuries among hospital waste handlers in selected government health facilities of Bhopal district." *Int J Health Sci Res* 5, no. 5 (2015): 37-43.