IMPACT OF EDUCATIONAL INTERVENTION ON SEGREGATION FOR EFFECTIVE BIOMEDICAL WASTE MANAGEMENT AMONGST HEALTHCARE PROFESSIONALS IN TERTIARY CARE HOSPITAL

Shilpa N. Kaore[1], Navinchandra M. Kaore[2], Anusheel A. Vasnik[3], Ranjeet Kumar[4], Sonali Meshram[5], Avantika Thakur[6]

[1]Professor and HOD, Department of Pharmacology, Raipur Institute of Medical Sciences, Raipur, Chhattisgarh, India.
[2]Professor and HOD, Department of Microbiology, Raipur Institute of Medical Sciences, Raipur, Chhattisgarh, India.
[3]Tutor, Department of Pharmacology, Raipur Institute of Medical Sciences, Raipur, Chhattisgarh, India.
[4]Assistant Professor, Department of Pharmacology, Raipur Institute of Medical Sciences, Raipur, Chhattisgarh, India.
[5]Tutor, Department of Pharmacology, Raipur Institute of Medical Sciences, Raipur, Chhattisgarh, India.
[6]Tutor, Department of Anatomy, Raipur Institute of Medical Sciences, Raipur, Chhattisgarh, India.

ABSTRACT

BACKGROUND

Biomedical Waste (BMW) includes all type of waste generated by the different healthcare establishments, laboratories and research facilities. Effective Biomedical Waste management is emerging as an issue of major concern because of the harmful effects on the health and the environment. Proper knowledge, attitude, practices and a clear understanding of their roles and responsibilities in handling BMW will help prevent the harmful effects.

MATERIALS AND METHODS

After due approval from Institutional Ethics Committee, a prospective analytical follow-up study was conducted at a tertiary care hospital. A total of 80 consenting health care professionals (HCP) were included in the study and were grouped as junior residents, staff nurses, technical staff and house-keeping staff. Each group was subjected to a pre-validated pretest questionnaire to assess the knowledge and attitude and their practices observed over a couple of days with checklist with the help of volunteers on the basis of observation checklist and key informant interview guide to collect data from all health personnel in health centers regarding waste management. All the groups were again subjected to post- test questionnaires. Data was managed in Microsoft Excel and was analysed using tests of proportions and paired t test with post hoc analysis using one-way ANOVA.

RESULTS

The difference in mean score of junior residents was found out to be 5.52 followed by 4.67 & 4.15 for nursing staff and technicians. The percentage rise in learning outcome was 32.59 %, 37.4 % and 36.72 % respectively which was highly significant. By post hoc analysis between the groups, junior residents were found to be better in pre-test as well as post-test with p-value of <0.001. 75 % and above participants perceived the interventional program and the methods involved to be similar to fun games, and they achieved better clinical orientation through them.

CONCLUSION

The knowledge and attitudes between the groups of healthcare personnel varied and was found to be satisfactory after the educational intervention was done. Training programs with periodical sensitization sessions on BMW management are recommended at all levels so that they are aware of serious health implications to the non-compliance to BMW practices.

KEY WORDS

Housekeeping Staff, Nursing, Periodic Training, Sharp Waste Management.

BACKGROUND

Biomedical Waste (BMW) includes all types of waste generated by the different healthcare establishments, laboratories and research facilities. Assessment survey conducted in developing countries in 2002 by the WHO reveals that 18 to 64 % establishments don't have proper biomedical waste disposal practices.[1]
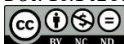
It is observed that institutions or health care facilities should be well equipped with BMW management in an effective, efficient way to save ourselves, our patients, and at large, to save our environment and our planet Earth. The ill effects of BMW management is a neglected issue in hospitals of developing countries due to poor practices among health staff with a particular concern about infection with human immunodeficiency virus (HIV) and hepatitis viruses B and C, for which there is strong evidence of transmission via health-care waste, especially sharp injuries.[2]

Mainly, 75–90% of medical waste is non-infectious, while 10–25% is the infectious waste that needs proper disposal. Infectious waste contains harmful items such as sharps, syringes, needles, blades, human parts, waste contaminated with blood, body tissue, body secretion and vomitus of the patients and other contagious and infectious items that need to be disposed properly by the trained personnel. Needle

prick injuries, especially among the health care personnel who handle the waste, is a major challenge. As much as about 12, 000 million injections were used every year and constitute about 1% of sharp waste globally.[3,4]

Effective Biomedical Waste management is emerging as an issue of major concern because of the harmful effect on the health and the environment and constitute about 1 -2 % of the total municipal solid waste.[5,6] It is estimated that annually about 0.33 million tons of wastes are generated in India.[6]

Study conducted by the central pollution control board (CPCB) has been evaluated for the disposal procedure and found that almost 56% biomedical waste is disposed of with the municipal waste. The investigator has experienced in his professional experience that, most of the bio-medical waste handlers are unaware of the categories of biomedical waste, colour coding of the containers, segregation, transportation, treatment and disposal etc.[6]

The Ministry of Environment and Forests notified the "Bio-medical Waste Management and Handling Rules", in July 1998 (later amended in 2003 and 2011) under the Environment Protection Act, 1986 with the latest updates coming in 2016. But without proper implementing and monitoring agencies in place the effective Bio Medical waste management practices are still lacking.[7] Failure to comply with the provisions of the Rules, will attract penal action as per the provisions of the Environment (Protection) Act, 1986, which includes imprisonment for a period of 5 years or a fine of Rs. 1 lakh or both.[7]

A proper knowledge, attitude and the practice by the health care professionals about the rules and regulations of BMW and a clear understanding of their roles and responsibilities in handling BMW with proper segregation can go a long way towards the safe disposal of the hazardous BMW and protect the community from various adverse effects.

In lieu of the same the study is designed to look for the change in knowledge, attitude and practices towards effective Biomedical Waste Management after educational intervention in healthcare professionals as well as their perception towards the educational interventional programs.

MATERIALS AND METHODS

After due approval from Institutional Ethics Committee, a prospective analytical follow-up study was conducted at a tertiary care hospital. A convenient sampling of 80 consenting health care professionals (HCP) was done with 20 in each group of junior residents, staff nurses, technical staff and house-keeping staff; each HCP being active members for delivering medical care in a tertiary teaching hospital.

Each group was subjected to a pre-validated pretest questionnaire to assess the knowledge and attitude and their practices observed over a couple of days with checklist with the help of volunteers on the basis of observation checklist and key informant interview guide to collect data from all health personnel in health centers regarding waste management. Each group was subjected to training and demonstration of the segregation of BMW according to recent guidelines of BMW management rules 2016. The training involves the didactic lectures, demonstrations and fun games. All the groups were again subjected to Post- test questionnaires.

Didactic Lecture

The didactic lecture covered, focused and emphasized the sections like- "Existence of Biomedical Waste rules", "Categories of Waste", "Different colour codes used" and "Waste segregation methods". In addition, other features of study constituted was interviewing the participants regarding the salient aspects of needle stick injuries.

Learn by Fun

An innovative idea was implemented in regard to "hands-on training" for all the participants. For this, various colour coded boxes representative of the colour coding in BMW management were kept in-front of them. They were then asked to put chits (2 each) in respective boxes according to the rules of colour coding before the educational intervention was done and repeated afterwards too.

Android Application for Smartphones

In addition, the participants were also told about a very interesting and innovative application (App) to be downloaded from Google store, Biomedical Management, Launched by All India Institute of Medical Sciences (AIIMS), New Delhi.[8] All participants were first briefed about android application that consists of two modes; Training mode, Game mode. Training mode teaches you regarding the correct colour coding match and the details of each and every item that is to be segregated in a specific bin or container with pictorial representation for easy understanding even by non-technical staff like house-keeping staff. One can practice as per their convenience anytime on this android application.

Data was managed in Microsoft Excel and was analysed using tests of proportions and paired t test. The post hoc analysis using one-way ANOVA i.e. Analysis of Variance was done to know the best outcome in terms of the learning outcome.

RESULTS

The groups were informed through participant information sheet and written informed consent taken before the Pre-Test was being administered. The small groups were then imparted training through power point presentation as well as fun games i.e. the coloured boxes and the android application to make them practice segregation. They were made aware about the BMW application, downloaded on their own smart phones for further ease of learning. The post test was carried out to know their learning outcome.

Number of correct responses from different streams of Health Care Professions in Pre-test and Post-test and % improvement in learning outcome after educational intervention is being tabulated in Table 1 to 3.

Questions		House Keeping			Nursing Staff			Junior Residents			Technicians		
		PeT	PoT	LO	PeT	PoT	LO	PeT	PoT	LO	PeT	PoT	LO
1	Knowledge in General about Bio-Medical Waste Generation	17	20	15	10	18	40	8	20	60	12	17	25
2	Is Biomedical Waste Management an Important Issue?	20	20	0	13	20	35	19	20	5	16	20	20
3	BMW Practices can reduce Hospital Acquired Infections	17	19	10	16	20	20	20	20	0	16	20	20
4	Departments concerned with Generation of Biomedical Waste	14	16	10	10	20	50	15	20	25	5	9	20
5	Amount of Waste Generated/Pt./Bed/Day	16	18	10	8	18	50	12	20	40	4	15	55
6	Proportion of Hazardous Waste Generated out of Total Waste	7	18	55	7	15	40	6	18	60	2	4	10
7	Existing BMW Categories	16	19	15	8	17	45	8	20	60	9	15	30
8	As per BMW Rules, Waste should not be Stored Beyond 48 Hours	13	18	25	0	18	90	12	20	40	4	14	50
9	Knowledge Regarding Penalization if BMW Rules are not Followed	10	20	50	3	15	60	12	20	40	9	20	55
Table 1. Number of correct responses from different streams of health care professions in pre-test and post-test and %age improvement in learning outcome after educational intervention for 1st nine questions (question 1 to question 9) on basic knowledge about BMWM 2016													

PeT- Pre-Test.

PoT- Post Test.

LO - % of learning outcome over pre-test.

Questions		House Keeping			Nursing Staff			Junior Residents			Technicians		
		PeT	PoT	LO	PeT	PoT	LO	PeT	PoT	LO	PeT	PoT	LO
10	Identification of Bio-Hazard Symbol	15	20	25	12	20	40	19	20	5	16	20	20
11	Separate Permit is Required for BMW Transport	18	19	5	4	18	70	18	20	10	16	17	5
12	Number of Colour Coded Bags/Containers	14	18	20	11	18	35	11	18	35	12	18	30
13	Waste Discarded in Red Containers	7	10	15	11	16	25	5	14	45	5	11	30
14	Waste Discarded in Yellow Containers	13	19	30	10	14	20	0	15	75	4	11	35
15	Waste Discarded in Blue Containers	7	14	40	12	20	40	5	18	65	5	20	75
16	Waste Discarded in White Leak Proof Containers	7	14	35	9	18	45	8	18	50	6	20	70
17	Awareness about Discarding of Needles	0	7	35	10	11	5	8	11	30	6	10	20
18	Awareness about Injuries by Sharps/Needles	13	15	10	8	14	30	4	19	75	10	12	10
Table 2. Number of correct responses from different streams of health care professions in pre-test and post-test and % improvement in learning outcome after educational intervention for nine questions (question 10 to question 18) on segregation practices in BMWM 2016													

PeT- Pre-Test.

PoT- Post-Test.

LO - %age of learning outcome over pre-test.

Questions		House Keeping			Nursing Staff			Junior Residents			Technicians		
		PeT	PoT	LO	PeT	PoT	LO	PeT	PoT	LO	PeT	PoT	LO
19	Colour of Container where Segregation of Glass Waste Is Done	17	18	5	12	18	30	16	18	10	12	20	40
20	Colour of Container where Gloves are Discarded	15	19	20	14	19	25	11	17	30	5	18	65
21	Colour of Container where Segregation of Catheters/ IV Sets Is Done	18	18	0	12	18	30	16	20	20	12	16	20
22	Colour of Container for Solid Chemical Waste Segregation	7	11	20	4	18	70	8	10	10	2	16	70
23	Status of Use of Chlorinated Bags for BMW Segregation & Disposal	3	11	40	7	14	35	6	18	60	2	6	20
24	Harm/Consequences of Needle Stick Injuries	17	17	0	19	20	5	19	20	5	18	20	10
25	Is Needle Stick Injury a Concern?	15	17	10	20	20	0	20	20	0	18	20	10
26	Status of Recapping Needle After Use	2	15	65	7	15	40	9	20	55	8	15	35
27	Should all HCPs be Vaccinated for Hepatitis B- a Preventable Disease	13	19	30	18	20	10	20	20	0	13	20	35
Table 3. Number of correct responses from different streams of Health Care Professions in Pre-test and Post-test and % improvement in learning outcome after educational intervention for Nine Questions (Question 19 to Question 27) on attitude regarding implementation of BMWM 2016													

PeT- Pre-Test

PoT- Post Test

LO - %age of learning outcome over pre-test

The total scores of the Pre-test and post-test for all HCP were analysed as tabulated in Table 4.

Module	Pre-Test Mean Score ± SD #	Post- Test Mean Score ± SD	Difference in Means Score	%age Rise in Learning Outcome in Post-Test over Pre-Test	P Value on Paired T Test And Significance
House Keeping Staff	15.7 ± 2.63	19.22 ± 3.97	3.52	22.45 %	<0.003 Significant
Nursing Staff	12.5 ± 3.88	17.17 ± 2.85	4.67	37.4 %	<0.001 Highly Significant
Junior Residents	16.95 ± 3.49	22.47 ± 1.87	5.52	32.59 %	<0.001 Highly Significant
Technicians	11.3 ± 2.75	15.45 ± 3.09	4.15	36.72 %	<0.001 Highly Significant
Table 4. Mean difference of scores in learning outcome with percent rise as compared to the pre-test in different groups of HCP					

\# SD= Standard Deviation.

As a part of post hoc analysis between groups comparison was then carried out using single factor ANOVA test for the Pre-test as well as post-test performance of the health care groups.

The results are as tabulated in Table 5 and Table 6 for Pre and post-test respectively.

	Count	Sum	Average	Variance	p Value using ANOVA for Comparison between Groups
House Keeping Staff	20	314	15.7	6.93	
Nursing Staff	20	250	12.5	15.13	P value < 0.0001
Junior Residents	**20**	**339**	**16.95**	**12.23**	Highly Significant for Junior Residents
Technicians	20	226	11.30	11.30	
Table 5. One-Way ANOVA for Pre Test					

	Count	Sum	Average	Variance	p Value using ANOVA for Comparison between Groups
House Keeping Staff	20	343.5	17.175	8.165132	
Nursing Staff	20	384.5	19.225	15.80197	P value < 0.0001
Junior Residents	**20**	**449.5**	**22.475**	**3.5125**	Highly Significant For Junior Residents
Technicians	20	309	15.45	9.55	
Table 6. One-Way ANOVA for Post Test					

As shown by the analysis the Junior residents have performed the best amongst all groups of HCP in pre-test as well as post-test. The House keeping staff closely followed in the pre-test but lagged in post-test analysis between the groups.

It shows with little variance and highest average the Junior Residents Group has performed the best amongst the groups which is highly significant.

All the groups of HCP were asked to provide their perception and feedback about the educational program on a predefined questionnaire. Perception of the HCP was taken on Likert's Scale as shown in Table 5 as well as subjective opinion regarding hurdles in implementation of the program was sought.

Sr. No	Perceptions	SA (05) Number (%)	A (04) Number (%)	SWA (03) Number (%)	DA (02) Number (%)	SD (01) Number (%)
1	Fun Games with direct demonstration are better tools than PPP in teaching about BMWM	42 (52.5)	28 (35.00)	8 (10.00)	2 (2.5)	0 (0.00)
2	The Android application has motivated for self-directed learning	50 (62.5)	28 (35.00)	2 (2.5)	0 (0.00)	0 (0.00)
3	Repeated programs like this are needed to strengthen the BMWM practices	35 (43.75)	28 (35.00)	8 (10.00)	5 (6.25)	4 (5.00)
4	Program helped in better application of knowledge in clinical laboratories and wards	50 (62.5)	15 ((18.75)	5 (6.25)	8 (10.00)	2 (2.5)
5	Repeated programs like this will help remember the BMWM practices especially the segregation practices	35 (43.75)	37 (46.25)	0 (0.00)	4 (5.00)	4 (5.00)
Table 7. Perception of the HCP for Educational Interventional Program carried out to Improve the Learning Outcome about BMWM						

SA=Strongly Agree, A= Agree, SWA= Somewhat Agree, DA= Disagree & SD= Strongly Disagree
Number in bracket indicate Percentage

Taking into consideration the strongly agree and agree parameters around 75 % participant felt that fun games keep them better involved with knowledge of application in real life settings. Around 73.75 % participants felt that repeated

programs like this should be organized by the institute whereas 81.25 % felt that it helped them in better application at their workplace. Around 82.5 % people appreciated the android application and were of the opinion that now they are having a ready reckoner to look for and will be like "guide by the side" for them and will refer to it more often wherever, whenever required without any hesitation. Still 90 % participants were of the opinion that repeated programs like this involving active interaction of the participants, doing the tasks of fun games themselves was interesting, enjoyable and will help remember the BMWM practices especially the segregation practices.

As per the subjective opinion around 80 % of the participants shared that BMWM rules 2016 were not clearly known to then and they were shy enough to ask for the help. With the android application in smart phones now, they will be more independent and self-sufficient now regarding the same.

Almost all the participants reiterated the need of posters and segregation containers, needle destroyers at all the places and should be replenished promptly.

The participants were also observed on day to day basis by the volunteers for their practice on BMWM on a scale of 1 to 10 with one being poor and 10 being excellent (Poor = 0-3, Good = 4-7, Excellent = 8-10).
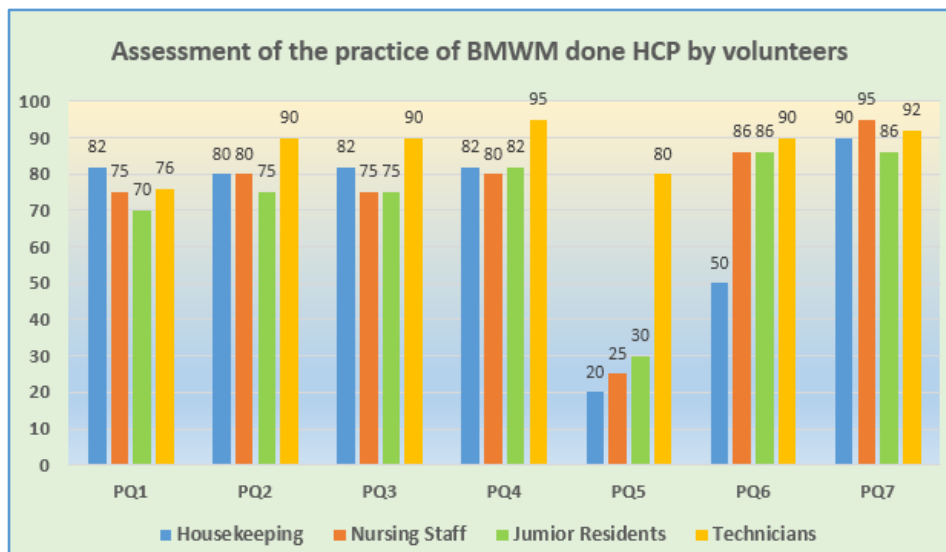
The graphical representation of the cumulative score for all HCP groups is depicted in Fig. 1. The overall data indicates the will to implement the BMWM practices by the HCP. There is need to provide the needle destroyer and the adequate supply of the colour coded bags at all levels as revealed from PQ5 and PQ6 in graph which shows the sparse supply of the same at Nursing and Housekeeping levels-

1. PQ1- Handling of Infectious Waste.
2. PQ2- Segregation Practices by HCP.
3. PQ3-Use of appropriate colour coded bags for segregation.
4. PQ4-Disposal of used needles.
5. PQ5-Availability of Needle destroyer at appropriate places.
6. PQ6- Availability of colour coded bags.
7. PQ7- Assessment of improvement of BMWM practices on constant vigil.

DISCUSSION
The waste produced in the course of healthcare activities carries a higher potential for infection and injury than any other type of waste. Its improper disposal can have direct and indirect health impacts as well as pose a potential threat to the surrounding environment, persons handling it, and the public in general.[2]

Improper disposal of biomedical waste is of huge public health concern. Gastrointestinal infections of Salmonella, hepatitis A through faeces or vomitus, human immunodeficiency virus, and hepatitis B via blood and body fluids, infected sputum samples leading to tuberculosis are only to name a few. Cytotoxic drugs (Alkylating agents) are powerful irritants on eyes and skin. Radioactive waste exposure can cause headache, dizziness, vomiting, genotoxicity, and tissue damage. Infected sharps can lead to physical injuries and further spread of blood borne diseases.[9] Moreover, practices of the healthcare personnel begin with their career and usually become habits that are difficult to change thereafter, so it's important to take cognizance of BMW segregation practices at the earliest. This indicates the importance of addressing BMW management issues amongst health care personnel. The training program and periodical sensitization sessions on BMW management is the need of the hour for motivation and change in mindset of all the healthcare personnel especially those in the junior level.[2]

A study conducted in a tertiary care hospital in Puducherry among health care personnel to know the awareness regarding knowledge, attitude and practices. A total of 337 personnel participated in the study (63 residents, 154 nursing staff, 23 lab technicians & 97 MPWs) participated in the study where observations were similar as in our study as per comparison at pretest level is concerned.[10] But no educational intervention was carried in this study. Results showed that <50% of nursing staff and <25% of MPWs had the knowledge of colour coding and segregation, poor knowledge regarding disposal of sharps among HCP, while majority had good knowledge regarding the diseases

transmitted through improper bio medical waste handling. Hence, concluded that overall awareness was not satisfactory.[10] We also observed similar results in our study in nursing group and other groups too. Noteworthy finding in our study was that all groups scored statistically significantly well in post-test in all aspects as knowledge, attitude and practices.

It is worthy to mention that attitude change of the HCPs would definitely require a longer period of time thus for long term changes to be assessed a period of at least 6 months or more may be required.[2] This notion is supported by observations in study by Pinto V et al as also observed in study by Ramesh Kumar et al [3] where a significant positive change in attitude and practices was seen after 18 months of training intervention.

Similar studies conducted at primary, secondary as well as tertiary care hospitals secondary, tertiary health centers of private and governments institutes in India in urban and rural areas and assessed for the state of BMWM. Multivariate analysis indicated that charts at point of waste generation, availability of designed person, appropriate containers and bags, availability of functional needle destroyers, availability of personal protective gears, segregation of waste at point of generation and log book maintenance were independently associated with better BMWM system in health facilities. This was true for both rural/urban, public/ private facilities.[11]

In our study, the participants were given gradation from poor, good and excellent depending on the marks scored by them. Regarding this data, we found 30% participants got poor scores in nurses and technicians' group only; 60% residents, 70% nurses and technicians, 90% housekeeping scored good while 10% in housekeeping and 40% in residents group scored excellent in pretest. As far as post-test is concerned, data suggested only 5% participants got poor score in nurses and housekeeping group; while 15% technicians, 45% nurses, 60% housekeeping and 100% of residents were in excellent scoring group; whole of the residents group obtained excellent score in post-test. (Table 1, 2 & 3)

In our study, we found that there was statistically significant improvement in knowledge, attitude and good practices in accordance to BMW management rules (Table 1, 2, 3), similar findings were found in a study done at a tertiary care hospital by Yaddavaanavar et al.[11] Significant improvement in knowledge, attitude in post-test was observed in all groups; but the improvement was not only significant but was highly significant as shown in Table. 4 (<0.001). While the residents' group was found to be the best in post-test, i.e. statistically significant (<0.0001) as per the values in Table 5, data suggested that the same group also fared best in pretest in comparison to all other groups. The pretest study observations suggested that 85% i.e. majority of HCP already agreed upon that BMW is an important issue, however all HCPs were not aware of all the sources of BMW generation. But a good observation was that all were aware of the fact that executing segregation practices in a proper manner would definitely decrease the overall incidence of hospital acquired infections. They were also aware of increased length of stay of patients if it occurs, and that increase in length of stay is one of the quality indicators for a

hospital service. Data suggests that 70% of the participants were able to shortlist at least 75% of sources BMW generation i.e. the departments that contributes to generation of waste in all groups; and this was quite significant in housekeeping group where 98% participants were able to point out all the possible sources. This observation in an away reflects their sincerity in day-to-day routine work. Regarding the number of existing categories of BMW, 75% technicians and 80% housekeeping staff knew the categories exactly, while it was known to only 40% of the nursing staff and residents. Further, we enquired about the BMW rules in terms of period allowed for BMW storage, awareness about punishment if rules are not being followed; we found the awareness regarding these was 60% in residents, 15% in nursing staff, 50% in housekeeping staff and 45% in technicians group.

In our study, regarding assessment of knowledge about BMW segregation practices indicated that majority HCP were knowing about the colour coding and the items segregated in these, but this was restricted to their nature of work, they knew about the common waste they dealt on daily basis like gloves, catheter, syringes, cotton swab, but had less knowledge about the waste not of their concern in routine day-to-day practice; for example, HCP of Obstetrics & Gynaecology department knew about the segregation of placenta, but didn't knew about microbiology laboratory waste autoclaving/ segregations and vice versa. Hence, this confusion was also reflected in pretest as well as post-test. Observations are definitely suggestive of statistically significant improvement in score of groups.

Our study the participants were ware of segregation practices, colour coding, handling of sharps and their consequences and agreed that they got a better and clear insight after the educational intervention which was clearly reflected in post-test scores. All groups emphasized the role of regular training in this regard. The problems underlined in poor implementation were poor availability of gloves, gowns, plastic bags, needle destroyers, less man power, no regular monitoring, lack of team work and busy work schedule. Study by Malini et al at Puducherry reiterated the same [10]

75% of participants perceived that fun games using the android application launched by AIIMS, New Delhi or Play way method of teaching through games is much better for understanding in a non-threatening environment. The idea that they are now having a ready reckoner in terms of Android application motivated the staff to be more self-reliant and confident. (Table 7)

CONCLUSION

Knowledge and attitudes among the groups of healthcare personnel varied and was found to be satisfactory after the educational intervention was done. Training programs with periodical sensitization sessions on BMW management are recommended at all levels so that they are aware of serious health implications to the non-compliance to BMW practices. HBV vaccination of all healthcare workers should be must. Assessment of long-term outcome of regular intervention should be done.

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