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RESEARCH ARTICLE

IMPACT OF TRAINING ON BIO-MEDICAL WASTE MANAGEMENT AMONG HEALTH CARE WORKERS IN A RURAL HOSPITAL OF TAMILNADU, SOUTH INDIA

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Manuscript Info	Abstract
	Inadequate and inappropriate knowledge of handling of healthcare waste may have serious health consequences and a significant impact on the environment as well. **Aim:** To assess the impact of intervention on the knowledge of health care workers regarding bio-medical waste management. **Materials and methods**: A hospital based intervention study was carried out from January 2022 to December 2022 in Government Thiruvarur Medical College and Hospital, Thiruvarur, Tamilnadu among healthcare workers. Pretested, pre-designed performa was used for data collection. Impact of training was assessed on 3rd and 9th month after training. Data was entered and analyzed using SPSS 17. **Result**. Out of 155, 82 (52.9%) were nursing staff, 34 (21.9%) were paramedical staff & 39 (25.1%) were group-D workers. Almost half of 76 (49%) HCWs were in the age group of 26 to 30 years. Knowledge of HCWs was increased from 66.7% to 86.7 % at 3 month which was decreased to 80 % at 9 month this suggests a regular training of HCWs for their and patient safety. **Conclusion:** The training session significantly improved the HCWs' knowledge, attitude and implementation of biomedical waste management. The need of comprehensive training programs at frequent intervals regarding BMW management is highly recommended to all hospital staff.

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Introduction:-

Managing biological waste improperly puts individuals, healthcare professionals, the community, and therefore the environment at severe danger (WHO, 2007). Biomedical waste (BMW) is waste-generated during diagnosis, treatment or immunization or in research activities pertaining thereto, or within the production and testing of biologicals, and is contaminated with human fluids.(1) The waste produced by healthcare activities carries a higher potential for infection and injury than any other type of waste.(2) Annually about 0.33 million hospital waste is

generated in India and, the waste generation rate ranges from 0.5 to 2.0 kg per bed per day.(3) All BMW generated within the hospital should be disposed off strictly in accordance with Biomedical Waste Management and Handling Rule 1998. Schedule I of which, describes the categories of BMW, their treatment and disposal methods.(2) In India, the Ministry of Environment and Forests has promulgated the Biomedical Waste (Management and Handling) Rules 1998 for proper segregation and disposal of Bio Medical waste based on colour coding . These rules are meant to enhance the overall waste management of health care facilities in India.(4,5) Although, there's an increased global awareness among health professionals about the hazards and also appropriate management techniques but the level of awareness in India is found to be unsatisfactory.(6)

The highest risk of biomedical waste is from the infectious and sharp components of the waste because of the HCWs and people associated with handling waste are often getting needle prick injuries.(7) WHO has estimated that about 5% of latest HIV infections in developing and transitional countries may be attributable to unsafe health care injections, including unsafe blood and occupational exposure. Medical waste is infectious and unsafe. It poses serious threat to environmental health requires specific treatment and management before its final disposal. As in current scenario there are increasing hospitals, clinics, and diagnostic laboratories in many cities. Absence of proper waste management, lack of awareness about the health hazards from Bio Medical waste, insufficient financial and human resources and improper waste disposal are the foremost critical problems connected with health care waste leading to devastating complications .(8)

Methodology:-

A hospital based intervention study on health personnel (Nursing staff, Paramedical staff, Group-D) from January 2022 to December 2022, in Government Thiruvarur Medical College and Hospital, Thiruvarur, Tamilnadu. A total of 180 HCWs [105 nursing staff, 40 paramedical staff & 35 group-D workers] were working in Government Thiruvarur Medical College and Hospital. Out of these only 155 filled up the questionnaire on schedule and underwent training because others were not willing to participate in the study. A total of 2 training sessions were organized each of 2 hours duration with break for 10 minutes for consecutively 2 days for HCW. Convenient days & dates were selected and schedule of training was prepared & approved from administrative heads. Training schedule was displayed at appropriate places & HCW was personally requested by the investigator to attend the training programme. On first day, 38 & second day, 39 HCW attended the training. A total of 77 HCWs were used for assessment of our impact on training. Two follow up visits were given to each HCW at 3rd and 9th month after training.

Study tools:

Predesigned, pretested, questionnaire schedule were administered to all HCWs. Questionnaire schedule were designed & validity of the questionnaire were assessed using the opinion of experts from our institute. It contains following parts: Part I, included demographic data, age, sex, designation ,years of experience, level of education, professional qualification, 2) Part II, included 15 questions of knowledge regarding Bio Medical waste 3) Part III, 15 questions for finding out health care workers' attitude towards BMWM. 4) Part IV, includes 8 questions to check practices of HCWs towards BMWM. The weaker areas of knowledge, attitude& practices were found out after pre training assessment of responses of HCWs. The power point presentation was prepared to address those weaker areas.

The KAP of Subjects toward BMWM questionnaire items were rated and scored according to the following patterns.

Scoring:

For this study purpose, Knowledge was scored, +1 was given for the correct answer and 0 for the incorrect answer. Scoring was done. Score 0-30% was considered as poor knowledge, 20-60% considered as average knowledge and >60% as good knowledge. Attitude was also scored, and grading was done.

Data analysis:

Data was analyzed as percentages for qualitative variables and mean, and $\pm$ SD for quantitative variables. Difference between the proportions were observed by Chi Square test/Fishers Exact test for independent group and Cochrane Q test for paired observations of two follow up. Data collected in this study was analyzed by using SPSS-17.

Ethical issues:

This study was accepted by institutional ethical committee. Written Informed consent was taken from all of our study subjects. Data was kept confidential and findings were shared only with the concerned authorities

Results:-

A total of 155 HCWs [105 nursing staff, 48 paramedical staff & 77 group-D workers] were selected and interviewed . Among them 77 HCWs were selected for the assessment of impact of training.

Out of 155, 82 (52.9%) were nursing staff, 34 (21.9%) were paramedical staff & 39 (25.1%) were group-D workers. Almost half of 76 (49%) HCWs were in the age group of 26 to 30 years. Majority 84 (54.2%) of HCWs were female and 71 (45.8%) were male. Less than half of HCWs (43.8%) were educated up to senior secondary. Maximum (95.1%) nursing staff had general nursing midwifery (GNM) level of professional qualification. All paramedical staff had diploma in their respective disciplines. Less than half 74 (47.7%) of HCWs had 10 years of work experience. Most HCWs had received the same training before [72 (87.8%) nursing staff, 32 (82.1%) group-D workers and 20 (58.8%) paramedical staff]. But most of group-D & paramedical workers had received training within one year than nurses. It was observed that majority of HCWs (64.5%) had received Hepatitis-B immunization. (Table 1)

Table 1:- Demographic characteristics of health care workers (HCWs).

Characteristics	Health Care Workers			Total (N=155) N (%)
	Nursing Staff (N=82) N (%)	Paramedics (N=34) N (%)	Group-D (N=39) N (%)	
Gender				
Male	12 (14.6)	25 (73.5)	34 (87.1)	71 (45.8)
Female	70 (85.3)	12 (26.4)	5 (12.8)	84 (54.2)
Age (in years)				
21-25	16 (19.7)	4 (11.7)	4 (10.2)	24 (15.4)
26-30	45 (54.8)	14 (41.1)	17 (43.5)	76 (49)
31-35	13 (15.8)	11 (32.3)	12 (30.7)	36 (23.2)
36-40	7 (8.4)	1 (2.9)	3 (7.6)	11 (7)
>40	1 (1.2)	4 (11.7)	3 (7.6)	8 (5.1)
Professional Qualification				
GNM	78 (95.1)	0 (0)	0 (0)	78 (50.3)
BSc & MSc Nursing	4 (4.8)	0 (0)	0 (0)	4 (2.5)
D. Pharma/Radio/Lab	0 (0)	34 (100)	0 (0)	34 (21.9)
None	0 (0)	0 (0)	39 (100)	39 (25.12)
Experience(in years)				
0-5	27 (32.9)	9 (26.7)	10 (25.6)	46 (29.6)
6-10	38 (46.3)	14 (41.1)	22 (56.4)	74 (47.7)
11-15	11 (13.4)	7 (20.5)	2 (5.1)	20 (12.9)
	6 (7.3)	4 (11.7)	5 (12.8)	15 (9.6)
Training received				
No	10(12.2)	14(41.2)	7(17.9)	31(20)
Yes	72(87.8)	20(58.8)	32(82.1)	124 (80)
Within 1 yr	43(59.7)	14(70.0)	23(71.8)	80(64.5)
More than 1 yr	29(40.3)	6(30)	9(28.2)	44(35.5)
Hep-B Immunization status				
Yes	65(79.2)	17(50)	18(46.1)	100(64.5)

| No | 17(20.7) | 17(50) | 21(53.8) | 55(35.5) |

Most of HCWs understood the meaning of contaminated waste [nursing staff 65(79.2%), paramedical staff 25(73.5%) and group-D workers 25(64.1%)]. Most of nursing staff were correctly knew about disposal of general waste & used cotton swab in correct colour coded bags than paramedical staff. Group-D workers had less knowledge regarding disposal of general waste & used cotton swab in respective colour coded bags. Nursing staff had significantly more knowledge regarding identification of correct colour coding for disposal of used cotton swab than paramedical & group-D workers. Nursing staff had significantly more knowledge of BMW generation through diagnosis, treatment & immunization than paramedical staff & group-D workers. (p<0.05). The attitude regarding BMWM was found to be high amongst nurses when compared with other HCWS. Practices of gloves wearing while handling BMW of nursing staff 72 (87.8%) were best as compare to other paramedical staff. Practices of nursing staff were significantly higher than other paramedical staff. (p<0.05) (Table 2)

Table 2:- Pre training knowledge regarding Bio medical waste management among HCWs.

Knowledge area (regarding BMWM)	Health Care Workers*			Total N=155 n(%)	p-value
	Nurses (N=82) n(%)	Paramedics (N=34) n(%)	Group-D (N=39) n(%)		
Understand the meaning of contaminated waste	65(79.2)	25(73.5)	25(64.1)	115 (74.1)	0.12
Identification of correct color coding for disposal of general waste	80(97.5)	32(94.2)	34(87.2)	146 (94.2)	0.08*
Identification of correct color coding for disposal of infected cotton swab	69 (84.1)	27(79.4)	23(59)	119 (76.8)	0.02*
Diagnosis generates biomedical waste	45 (54.8)	16 (47)	7 (18)	68(43.9)	0.002*
Treatment generates biomedical waste	66 (80.5)	22 (64.7)	23 (59)	111(71.6)	0.009*
Immunisation generates biomedical waste	47 (57.4)	15 (44.1)	6 (15.3)	68(43.9)	0.001*
Attitude among HCWs					
Rules & regulation must be strictly followed	79(96.3)	30(88.2)	34(87)	143(92.2)	0.05*
Colour coding is an easy method of segregation of biomedical waste	82(100)	29(85.3)	28(71.8)	139(89.7)	0.001*
Biomedical waste management is helpful in reducing spread of infections	80(97.5)	32(94.1)	33(84.6)	145(93.5)	0.04*
Practices among HCWs					
Wear gloves at the time of handling BMW	72 (87.8)	27 (79.4)	27(69.3)	126(81.3)	0.02*
Used needle destroyed	74(90.2)	26(76.2)	26(66.6)	126(81.3)	0.002*
Sharp waste disposed in puncture proof blue bag	72 (87.8)	28(82.4)	29(74.4)	129(83.3)	0.10

- **Paramedics & group-D clubbed together for purpose of analysis. –**
  *P value <0.05 significant using Chi square test

Overall impact of training on knowledge, attitude & practices of HCWs. Knowledge of HCWs was increased from 66.7% to 86.7 % at 3 month which was decreased to 80 % at 9 month. Positive attitude of HCWs was increased from 86.7% to 100 % at 3 month which was decreased to 93.3 % at 9 month. Practices of HCWs were increased from 62. 5 % to 87.5 % at 3 month which was decreased to 75 % at 9 month. (Table 3)

Table 3:- Overall Impact of Training on KAP of HCWs (N=77).

KAP	Baseline KAP (%)	Impact at 3 Month (%)	Impact at 9 Month (%)
Good Knowledge	**66.7**	**86.7**	**80**

Good Attitude	86.7	100	93.3
Good Practices	62.5	87.5	75

At the start of the study only 56 (72.7%) HCWs knew about contaminated waste and at the end of 3rd month and 9 th month, 67(87%) and 61(79.2%) respectively. Initially Most of the HCWs 67(87%) were aware about identification of correct color coding for disposal of general waste which was increased up to 76(98.7%) at 3 month and during 9th month follow up everyone were aware. Impact of training was significant. Majority of HCWs 66(85.7%) had knowledge of identification of correct color coding for disposal of infected cotton swab initially after training it was increased to 71(92.2%) and at 9 month it was 75(97.4%). There were significantly increase in the knowledge of HCWs over the study period. Baseline knowledge of HCWs regarding generation of biomedical waste through diagnosis was 42.8% which was increased up to 68.8% at 3 month & decreases to 55.8% at 9 month. Similarly knowledge of HCWs regarding generation of biomedical waste through treatment was 46.7% which was increased up to 76.6 at 3 month & decreases to 67.5 at 9 month. There was improvement in knowledge of HCWs regarding generation of biomedical waste through immunization was at 9 month 34 (44.2%) which was very low during the start of the study 18 (23.3%). There was decline in the attitude regarding BMWM during the follow up at 9 th month. Before training most of the HCWs 73 (94.8%) had positive attitude regarding rules & regulation of BMWM. It was increased to 76 (98.7%) at 3 month and decreased to74 (96.1%) at 9 month. Initially 96.1% HCWs had positive attitude regarding color coding as an easy method of segregation of biomedical waste which was increased up to 98.7% at 3 month & same decreased to 93.5% at 9 month. Baseline attitude of HCWs was 94.4% regarding biomedical waste management is helpful in reducing spread of infections. At 3 month it increased to 98.7% and decreased to 96.1% at 9 month. (Table 4)

Table 4:- Impact of training on knowledge, Attitude and practices of HCWs regarding BMWM.

Knowledge area (regarding BMWM)	Before training* n (%)	Impact of training at 3 month n (%)	Impact of training at 9 month n (%)	Cochrane Q test	P value
Understand the meaning of contaminated waste	56 (72.7)	67 (87)	61 (79.2)	Q=4.78	0.09*
Identification of correct color coding for disposal of general waste	67 (87)	76 (98.7)	77 (100)	Q=16.54	0.001*
Identification of correct color coding for disposal of infected cotton swabs	66 (85.7)	71 (92.2)	75 (97.4)	Q=7.17	0.02*
Diagnosis generate biomedical waste	33 (42.8)	53 (68.8)	43 (55.8)	Q=11.11	0.004*
Treatment generated biomedical waste	36 (46.7)	59 (76.6)	52 (67.5)	Q=15.44	0.001*
Immunisation generated biomedical waste	18 (23.3)	26 (33.7)	34 (44.2)	Q=8.93	0.01*
Attitdue among HCWS					
Rules & regulation must be strictly followed	73 (94.8)	76 (98.7)	72 (93.5)	Q=4.6	0.09*
Colour coding is an easy method of segregation of biomedical waste	74 (96.1)	76 (98.7)	72(93.5)	Q=4.6	0.09*
Biomedical waste management is helpful in reducing spread of infections	75 (94.4)	76 (98.7)	74 (96.1)	Q=3	0.22
Practices among HCWs					
Wear gloves at the time of handling biomedical waste	70 (90.9)	76 (98.7)	70 (90.9)	Q=4	0.13
Used needle destroyed properly	33 (42.8)	40 (52)	35 (45.5)	Q=9.55	0.008*
Sharp waste disposed in puncture proof blue bag	43 (55.8)	49 (63.6)	50 (65)	Q=5.14	0.07*

*P value <0.05 significant using Chi square test
(Paramedics & group-D clubbed together for purpose of analysis)

Discussion:-

Knowledge of BMWM among HCWs

Around three fourth of the health care workers knew the correct meaning of contaminated waste whereas other study carried out by N Nirupama et al, at Karimnagar,to assess KAP regarding BMWM reveals around half of HCWs knew correctly about BMW. (9) Nursing staff had more knowledge of BMW generation through diagnosis, treatment & immunization than paramedical staff & group-D workers. This was attributed to nurses being more involved in practical work & responsibilities given by higher authorities. Maximum HCWs had good knowledge regarding disposal of general waste. Significantly higher proportion of nurses had knowledge about disposal of infected waste in proper color coded bags than paramedical & group-D workers. Similar results were found in another study conducted by Mohammad Shafee, et al at Karimnagar. (9) A total 70.6% HCWs were having same idea about segregation of BMW & majority of HCWs 95.8% had knowledge about various health problem caused by BMW, of which only 48.8% were nurses.

The overall knowledge of HCWs was high but was highest among nurses. This could be explained by the fact that most of study subject had received special training on BMWM and more than half of the HCWs had received training within 1 year & also more involvement of nursing staff in patient care.

Attitude of Universal Precautions & BMWM among HCWs

Attitude of all was HCWs highly positive towards universal precautions. Attitude towards the colour coding is an easy method of segregation' of HCWs of present study is consistent with results of another study conducted by Mohammad Shafee, et al at Karimnagar. (9) Proportion of HCWs having positive attitude towards separation of infectious & non-infectious waste, proper disposal & implementation of rules & regulation was close to the findings of a survey carried out in Karimnagar (99.2%, 98.8% & 98.4% respectively). Also attitude of technicians & housekeeping staff also match with findings at Karimnagar.[9] It was found that significantly higher proportion of nurses had significantly positive attitude when compare to technicians & the housekeeping staff. Current study shows better attitude compared to results of previous study carried out in a 512 bedded multidisciplinary teaching hospital located in rural area by Deepali Deo et al in 2005 i. e. 76.63% in medical staff & 60% in paramedical staff. (10)

Practices of BMWM among HCWs

Regarding BMW practices, it was found that the nurses practiced BMW management better. Practices of gloves wearing while handling biomedical waste were highest among nursing staff 87.8%. In the present study the practice of wearing gloves while handling biomedical waste by group-D workers was high 69.3% compared to Paramedical staff. This is consistent with the another study carried out at the tertiary hospital in Agra by Shalini et al. (11) In present study majority of HCWs 83.3% disposed sharps correctly in puncture proof blue bag. Mathur et al, in a study conducted in Allahabad, found that regarding practices related to BMW management, sanitary staff were ignorant on all the practices.(12)

Impact of Intervention on Knowledge, Attitude & Practices of HCWs

The pre-intervention knowledge, attitude & practices of the participants were satisfactory in many aspects. But knowledge & practices in most of the important area regarding BMWM was limited. The intervention of this study emphasized not only the details of the routine procedure of universal precautions & well-known hazards of hospital waste but also on the sound preventive behavior and the fruitful effect of its application. The overall knowledge, attitude and compliance BMW were considered the main determinant of the program effect and not the improvement of a single knowledge or attitude item.

Regarding knowledge of BMWM, we asked the meaning of contaminated waste. At the time of first survey only 72.7% HCWs were understand correct meaning of contaminated waste which was increased up to 87% at 3 month. With time it declined to 79.2%. Reason behind this is that HCWs were not very much concerned with contaminated waste. Large number of HCWs identified correct colour coding for disposal of general & infected waste at the beginning which was significantly improved over the 3 to 9 month period. This improvement is due to HCWs seriously understood that key step in BMWM is "segregation must at the point of generation." Initially very few HCWs knew that diagnosis, treatment & immunization generate BMW. Impact of training on knowledge of HCWs was significant. But basic knowledge of BMW generation was limited in all HCWs. This might be due to the fact

that all HCWs do not understand clearly, the meaning of technical words such as diagnosis, treatment & immunization & are less concerned with generation of BMW. So that retraining should be organised to emphasize on these weaker & important areas.

Many of HCWs had initially satisfactory high attitude towards rules & regulation. Most of HCWs agree that colour coding is an easy method of segregation of BMW & biomedical waste management is helpful in reducing spread of infections. This intervention had significant impact of training on attitude of HCWs. High attitude is best indicator as knowledge & practices can be improved with educational/ training programme.

In the current intervention, baseline compliance of HCWs was good regarding universal precautions & BMWM. Many of the HCWs handled patients without hesitation. As an impact of training compliance of handling patient with due care was significantly increased. Majority of HCWs wore gloves at the time of handling BMW which was found to be increased at 3 month & came down to previous level. Practices of HCWs were surprisingly low i.e less than half HCWs did not taken proper immediate preventive measure after needle stick injuries. Impact of intervention was highly positive. As handling of sharp is critical issue, special training emphasized on these issues should organized & other option should be tried.

Conclusion and Recommendations:-
The findings of the study have implications for HCWs education, service, administration and research. Knowledge retention has its limit and practices are hooked in to knowledge, hence periodical in commission education is the solution to the proper bio-medical waste management. It helps health care providers with essential knowledge, skill and attitude for the protection of self from the infectious or non infectious waste while working within the health centers. It also helps the health care providers to guard the community from hazardous waste. to enhance overall knowledge and practice related to BMW management and its handling following steps can be taken like, strict implementation of bio medical waste management rules; it should be made compulsory for health care facilities to urge their health care personnel trained from accredited training centers, these training centers shouldn't become merely a onetime activity but should be a continuous process. Care givers and support personnel, must have periodic educational updates on bio-medical waste management. Nursing protocol should be made for handling infectious also as non-infectious wastes. Adequate supplies and equipments should be available altogether the departments to take care of waste properly. Nurses play an important role in imparting health services in all level viz, protection, prevention, promotion and treatment. Active participation in educating doctors by providing instructions and knowledge regarding bio-medical waste management should be encouraged. the necessity of comprehensive training programs regarding BMW management is highly recommended to all hospital staff. Wherever, generated, a secure and reliable method for handling of BMW is essential

Statement of conflict of interest
The authors declare that there is no conflict of interest associated with this study.

Contribution:-
The study was conceptualized and its design formulated by HN, MKV, GV, and RJ. Literature search and data collection were done by MKV, GV. Analysis and interpretation of data were done by HN, MKV, GV, and RJ. Drafting of the article was done by HN, MKV and RV. The manuscript was critically reviewed by GV and RJ. All the authors approved of the final manuscript draft. MKV takes the responsibility for the integrity of the work as a whole from inception to publishing of the article and may be designated as "guarantor" or key person for the study.

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