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Effectiveness of Outreach Clinical Mentoring and Supportive Supervision on Biomedical Waste Management in Nasarawa State, North Central Nigeria: An Intervention Study

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Abstract:-

- ***Introduction:***

Health care activities are essential because they restore health and save lives. At the same time however, they generate large quantity of wastes and by-products that need to be handled safely and disposed of properly. Proper health care waste handling is a worrisome issue around the world, especially in developing countries. This study is meant to determine the effect of clinical mentoring and supportive supervision on the knowledge of, attitude to and practice of biomedical waste management.

- ***Method:***

A quasi-experimental study design with both qualitative and quantitative components was used. A multistage sampling technique was used to select 436 study participants who met the inclusion criteria. The data tools were pre-tested interviewer-administered questionnaires and supervisory check lists for the quantitative component on the one hand, and a focus group discussion guide for the qualitative component on the other hand. The interventions were in the form of both physical and virtual mentoring and routine supportive supervision. The participants in the control arm of the study did not receive mentoring or supportive supervision. The study lasted for 24 weeks, within which there were weekly, scheduled mentoring/supportive supervisory visits to only the facilities in the study arm.

- ***Data Analysis:***

Quantitative data was collated, checked for completeness and analyzed using IBM Statistical Package for Social Sciences (version 23). Quantitative variables were described using frequencies, percentages, means and standard deviations. Chi-square test, Fisher's exact test and Paired t test were used to test associations. At 95% confidence interval, p-value less than 0.05 was considered statistically significant. Qualitative data was analyzed using Nvivo statistiscal software, version 11.

- ***Result:***

The mean age group of the study participants was 33.30(±8.97). More females (50.80%) than males (49.20%) participated in the study. Majority of the participants had tertiary education (88.45%). The predominant occupation was community health work (30.75%). In the study group, 66.4% of the respondents had poor knowledge score pre-intervention. This decreased significantly to 10.0% post-intervention ($p<0.05$). In the control arm of the study, there was no significant difference in the findings at the start and after the study. The proportion of respondents who had positive attitude score in the study arm, increased significantly from 40.3% before intervention to 77.8% after intervention ($p<0.05$). In a similar vein, the proportion with appropriate practice in the study arm also increased from 32.7% before intervention to 88.3% after intervention with a statistically significant difference. In the control arm, there was no significant difference in the findings at the beginning of the study compared to the findings at the end of the study. In the study arm, majority of the respondents who demonstrated poor knowledge of, attitude to and practice of health care waste management at the baseline focus group discussion sessions, showed significant improvement at the post-intervention sessions. In the control arm, there was no significant difference in the focus group discussion findings.

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➢ ***Conclusion:***

The findings above are suggestive of the fact that the interventions were effective. There is, therefore, the need for the establishment of incentive schemes like clinical mentoring and regular supportive supervision of health care workers on health care waste management in order to safeguard human, animal and environmental health.

Keywords:- *Attitude, Biomedical Waste Management, Knowledge, Mentoring, Practice, Supportive Supervision.*

I. INTRODUCTION

Health care activities protect health, restore health and save lives, but they generate wastes and by-products that are of utmost concern to humankind, animals and the environment.[1] About 85% of biomedical waste (BMW) is made up of general, non-hazardous wastes comparable to domestic waste. The remaining 15% is considered hazardous and may be infectious, poisonous or radioactive.[1]

All wastes generated in a health care setting and not intended for further use are described as BMW or health care waste (HCW).[2,3] High-income countries (HIC) generate on average, about 0.5kg of hazardous waste per hospital bed per day while low-income countries (LIC) generate on average, 0.2kg per day. However, HCW are often not separated into hazardous and non-hazardous wastes in LIC, making the real quantity of hazardous wastes much higher.[1,3]

Training on medical waste management, knowledge of the general principles of health care waste management and awareness of the health and environmental implications of medical wastes in developing countries, including Nigeria is still very poor. A study in Benue State found that training and sensitization regarding the health and environmental risk of medical waste was very poor.[4] Occupational hazards as a result of exposure to blood-borne pathogens and other hospital-based exposures are among the most serious health risks faced by healthcare workers in developing countries.[5] Another study in Zambia found that average annual sharps injury rate was 1.3 injuries per worker and only 8% of respondents were fully vaccinated against hepatitis B virus (HBV) infection.[5] The World Health Organization (WHO) estimates that each year, there are about 8 to 16 million cases of HBV infection, 2.3 to 4.7 million cases of hepatitis C virus (HCV) infection and 80,000 to 160,000 cases of human immunodeficiency virus (HIV) infection due to unsafe injections disposal and very poor waste management practices.[6] In spite of the relatively high frequency of these risk events, only 4% of cases are being reported in developing countries.[5,7] Legal and institutional policies on healthcare waste management are the basis for proper and efficient management of hazardous wastes globally.[8] Despite being a signatory to the Basel convention and the Stockholm convention, Nigeria has no specific national biomedical waste management policy or a coordinated legal framework within which hazardous wastes may be effectively managed.[8]

The most recent revision of the National policy on Environment did not make specific reference to healthcare wastes, in spite of their unique peculiarities. The policy only captured certain types of hazardous substances.[8] Studies bordering on real-time mentoring, supportive supervision or training intervention in health care waste management are very few in this environment. This study therefore, deployed the strategies of outreach clinical mentoring and supportive supervision to examine BMW management in selected health care facilities in Nasarawa State, north central Nigeria. Apart from adding to the pre-existing body of knowledge, the findings may act as a nidus for further research and will be presented to relevant stakeholders with the hope that it may influence policy decisions appropriately.

II. MATERIALS AND METHOD

➢ *Study Setting*

Lafia is the administrative capital of Nasarawa State and it is geopolitically located in the north-central region of Nigeria and geographically located between latitudes $8^0$20' and $8^0$53' north of the equator and longitudes $8^0$40' and $9^0$01' east of the meridian. It has a population of about 348,000 based on the projection of the 2006 population census. It is a predominantly agrarian setting with a tropical sub-humid climate with daily temperatures ranging between 23 and 37 Degree Celsius. There are 102 registered health care facilities (HCFs) in Lafia local government area (LGA), made up of 56 public health facilities and 46 private health facilities, spread unevenly across the 13 electoral wards of Lafia LGA.

➢ *Study Design*

The study used a hospital-based, quasi-experimental design with mixed qualitative and quantitative components.

➢ *Study Population*

The study population comprised staff who are directly involved in health care waste generation and handling in the selected health facilities.

➢ *Inclusion Criteria*

Health care facility staff who are involved in HCW generation and handling, staff who had worked for more than six months prior to the study and the operational heads of the selected facilities.

➢ *Exclusion Criteria*

Non-permanent staff and those that refused to give informed consent.

➢ *Sample Size Determination*

The minimum sample size was determined using the formula for comparing two proportions in two independent study samples (control group and intervention group).[9] :

$$n = \frac{(Z\alpha + Z_\beta)^2 \times 2 \times P\,(1- P)}{d^2}$$

➢ *Sampling Technique*

Multi-stage sampling technique was used to select study participants.

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- *Stage One: Selection of Health Care Facilities*

The 102 registered HCFs disproportionately spread across the 13 council wards of Lafia LGA were categorized into the 56 public HCFs and 46 private HCFs on the basis of ownership to enhance representativeness.

- *Stage Two: Selection of Study Arm*

The HCFs were further categorized into two groups: group 1 was the intervention group and group 2, the control group. Each group was made up of 30 health care facilities selected through simple random sampling. The 60 selected HCFs were earlier coded and randomly allocated into the two arms, the study arm and the control arm. Of the 436 study participants, 86 were drawn from primary health care centers (PHCs), 147 from secondary health care facilities and 203 from the only tertiary health care facility in the study setting. In respect of cadre, 102 nurses, 40 doctors, 49 pharmacists, 134 community health workers, 47 sanitary workers, 47 medical laboratory technicians and 17 medical laboratory scientists participated in the study.

- *Stage Three: Selection of Study Participants*

The list of staff that fulfilled the criteria for inclusion in the study in the respective facilities formed the sampling frame. Within each of the 60 selected facilities, systematic random sampling was used to select study participants. The first participant in each case was randomly selected and the others were systematically selected using the predetermined sampling interval.[9,10,] The total number of eligible participants across the 60 HCFs were 1,869. Proportional allocation of respondents was done by dividing the number of eligible participants in a particular facility by the total number of eligible participants across all the 60 HCFs (N =1,869), multiplied by the calculated sample size (n = 436):

Allocated sample size per facility = No. of eligible respondents in the facility x n

Total number of eligible respondents across all facilities

The sampling interval (k = 4), was determined by dividing the total number of eligible participants in all the HCFs by the study sample size:

$$K = \frac{N}{n}$$

➢ *Study Instruments*

Data collection instruments were:

- A structured, interviewer-administered questionnaire for quantitative data.
- An observational check list for quantitative data.
- A focus group discussion (FGD) guide for qualitative data.

➢ *Data Collection*

Advocacy visits were paid to the HCFs by members of the research team who had been trained on the research protocol. Data collection was done in stages.

➢ *Pre-Test of Study Instrument*

The questionnaire and the observational checklist were pre-tested on 44 randomly selected respondents (10% of n) in five randomly selected HCFs in Keffi LGA. This was because, Keffi, being the seat of the LGA administration, has socio-demographic characteristics comparable to Lafia, the actual study area.

➢ *Stage One (Baseline Data Collection)*

➢ *Quantitative Data*

Baseline quantitative data was collected in both group 1 HCFs and group 2 HCFs with the aid of the questionnaires. Where necessary, translators of language were used to enhance effectiveness and uniformity. The observational check lists were also filled at this stage. The check list is a catalogue of hands-on verifiable list of 20 questions/observations based on current practice of hospital waste management. Each correct observation or practice attracted one mark and a wrong observation or practice attracted zero mark.

➢ *Qualitative Data*

Baseline focus group discussion sessions were held with the selected participants in both arms of the study using the standardized FGD guide. 8 to 10 participants were randomly selected in each case for the FGD sessions. Aided by a recording device, the lead researcher acted as the moderator in all cases and the note takers were the research assistants. Each session lasted between 40 minutes and 1 hour or until saturation point was reached when there were no more emerging themes.

➢ *Stage Two (Intervention Phase)*

Participants from the study arm in each of the 30 intervention facilities received scheduled, one-day facility-based training on the general principles of biomedical waste management. In addition, group 1 HCFs were gifted printed waste management guidelines and information, education and communication (IEC) materials, as waste management incentives. The HCFs in the study arm were followed up for a period of 24 weeks, at the rate of one visit per month. During such visits, researchers, among other things, observed HCW management (HCWM) activities, worked hand-in-hand with health care staff, identified challenges, solved them collectively and filled the check lists. Between visits, virtual mentoring continued unabated with the aid of WhatsApp messages and phone calls. No supervisory visits were paid to the category 2 HCFs (control).

➢ *Stage Three (Post-Intervention Data Collection)*

After the 24-week follow up period, the same study instruments used at baseline were re-administered to the study participants in both arms.

➢ *Scoring and Grading of Responses*

Knowledge was assessed based on responses to the knowledge-related questions (8 to 48) on the questionnaire. One mark for each correct response and zero for incorrect or nil responses:

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$$\text{Knowledge percentage} = \frac{\text{Total knowledge score}}{\text{Maximum attainable knowledge Score}} \times 100$$

Score <50% was graded as poor knowledge and score ≥ 50% was graded as good knowledge.[11]

Same method was used to score/grade attitude and practice of HCWM.

➢ *Statistical Analysis*

Quantitative data was analyzed with IBM Statistical Package for Social Sciences version 23 software. The data was presented as tables, charts and graphs as necessary. Categorical variables were summarized using frequencies (freqs) and percentages. Continuous variables were treated using means and standard deviations. Differences in knowledge of, attitude to and practice of HCWM before intervention and after intervention were tested using Chi square test and Fisher's exact test. Paired t test was used to test the differences in the scores from the observational check list pre-intervention versus post-intervention and with confidence limit set at 95%, P<0.05 was considered statistically significant.

The audio recordings from the FGD sessions were transcribed verbatim and the emerging themes were coded and analyzed with Nvivo statistical software version 11. Parent nodes were knowledge of HCWM, attitude towards HCWM and practice of HCWM, whereas emerging themes in each dependent variable were coded as sub-nodes.

➢ *Ethical Consideration*

Ethical clearance for this study was obtained from the Health Research Ethics Department of the State's Ministry of Health, Lafia. Informed, verbal consent were duly obtained from the respondents. After the post-intervention data collection, participants in the control arm of the study were also trained on the general principles of HCWM in conjunction with presentation of waste management guidelines to the facilities.

➢ *Limitations of the Study*

The researcher may not have control over some inaccurate information that respondents may have possibly given. The follow-up period of 24 weeks may not be long enough to gauge the impact of some of the findings from this study.

III. RESULTS

The mean age group of the study participants was 33.30 (±8.97years). More females (50.80%) than males (49.20%) participated in the study. Majority of the participants had tertiary education (88.45%).

➢ *Quantitative Component:*

Table 1 Participants' Knowledge of Categories of Biomedical Waste by Study Status

Study Status				
Variables	**Study**		**Control**	
	Pre-intervention n=218	**Post-intervention n=218**	**Beginning of Study n=218**	**End of Study n=218**
	Freq(%)	**Freq(%)**	**Freq(%)**	**Freq(%)**
Sharps				
Yes	212(97.2)	218(100.0)	198(90.8)	199(91.3)
No	3(1.4)	0(0.0)	3(1.4)	5(2.3)
I don't Know	3(1.4)	0(0.0)	17(7.8)	14(6.4)
	218(100)	**218(100)**	**218(100)**	**218(100)**
	χ^2=:5.301 p-value=0.30**		χ^2=:0.809 p-value=0.722**	
Chemical wastes				
Yes	172(78.9)	218(100.0)	174(79.8)	171(78.4)
No	33(15.1)	0(0.0)	29(13.3)	33(15.2)
I don't Know	13(6.0)	0(0.0)	15(6.9)	14(6.4)
	218(100)	**218(100)**	**218(100)**	**218(100)**
	χ^2=63.210; p-value <0.001**$^{\pi}$		χ^2=0.329: df=2 ; p-value=0.848	
Liquid wastes				
Yes	171(78.4)	218(100.0)	184(84.4)	185(84.9)
No	25(11.5)	0(0.0)	14(6.4)	17(7.8)
I don't Know	22(10.1)	0(0.0)	20(9.2)	16(7.3)
	218(100)	**218(100)**	**218(100)**	**218(100)**
	χ^2=63.210; p-value <0.001**$^{\pi}$		χ^2=0.737: df=2; p-value=0.692	

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Biotechnology wastes				
Yes	146(67.0)	204(93.6)	117(54.2)	115(53.5)
No	35(16.0)	11(5.0)	64(29.6)	70(32.5)
I don't Know	37(17.0 **218(100)**	3(1.4) **218(100)**	35(16.2) **218(100)**	30(14.0) **218(100)**
	χ^2=51.033: df=2; p-value <0.001*		χ^2=0.668: df=2; p-value =0.716	

*Statistically significant, **Fisher's Exact, **$^{\pi}$ Fisher's exact test that is statistically significant

From table 1 above, 97.2% of the respondents in the study arm identified sharps as a biomedical waste category in the pre-intervention phase of the study and all the respondents (100%) in the post-intervention phase identified sharps as a waste category. In the control arm, it was 90.8% at the beginning and 91.3% at the end of the study. There was a statistically significant difference ($p<0.05$) in knowledge before and after intervention in the study arm as opposed to the control arm with a p-value = 0.67. All the respondents in the study arm also correctly identified chemical and liquid waste as waste categories after intervention.

Table 2 Participants' Knowledge of Colour Codes of Waste Bins used for Biomedical Waste Management by Study Status

Study Status				
Variables	**Study**		**Control**	
	Pre-intervention n=218	**Post-intervention n=218**	**Beginning of Study n=218**	**End of Study n=218**
	Freq(%)	**Freq(%)**	**Freq(%)**	**Freq(%)**
Yellow				
Yes	198(90.8)	218(100.0)	197(90.4)	201(92.2%)
No	3(1.4)	0(0.0)	9(4.1)	7(2.2)
I don't Know	17(7.8) **218(100)**	0(0.0) **218(100)**	12(5.5) **218(100)**	10(4.6) **218(100)**
	χ^2=22.623; p-value <0.001**$^{\pi}$		χ^2=0.472: df=2; p-value=0.790	
Red				
Yes	198(90.8)	218(100.0)	208(95.4)	206(94.5)
No	16(7.4)	0(0.0)	3(1.4)	3(1.4)
I don't Know	4(1.8) **218(100)**	0(0.0) **218(100)**	7(3.2) **218(100)**	9(4.1) **218(100)**
	χ^2=23.623; p-value <0.001**$^{\pi}$		χ^2=0.359; p-value=0.937**	
Black				
Yes	195(89.4)	214(98.2)	194(89.4)	197(91.6)
No	14(6.4)	4(1.8)	11(5.1)	8(3.7)
I don't Know	9(4.2) **218(100)**	0(0.0) **218(100)**	12(5.5) **218(100)**	10(4.7) **218(100)**
	χ^2=16.268; p-value <0.001**$^{\pi}$		χ^2=0.669: df=2; p-value=0.716	
Green				
Yes	65(29.8)	161(73.9)	60(28.0)	74(34.4)
No	84(38.5)	55(25.2)	110(51.4)	103(47.9)
I don't Know	69(31.7) **218(100)**	2(0.9) **218(100)**	44(20.6) **218(100)**	38(17.7) **218(100)**
	χ^2=110.054: df=2; p-value <0.001*		χ^2=2.129: df=2; p-value =0.345	
Purple				
Yes	39(17.9)	37(17.1)	14(6.5)	17(8.0)
No	103(47.2)	173(80.1)	133(62.2)	142(66.8)
I don't Know	76(34.9) **218(100)**	6(2.8) **218(100)**	67(31.3) **218(100)**	54(25.4) **218(100)**

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	χ^2=77.555: df=2; p-value <0.001*		χ^2=1.979: df=2; p-value =0.372	

*Statistically significant, ** Fisher's Exact

At baseline, 90.8% of respondents in the study arm agreed that yellow was a colour code for hospital waste bin and all the respondents (100%) agreed in the post-intervention phase that yellow was a colour code for hospital waste bin with a p-value less than 0.05. In the control arm, it was 90.4% at the beginning and 92.2% at the end of study with a p-value of 0.790 (not statistically significant).

Table 3 Participants' Knowledge Score on Biomedical Waste Management by Study Status

Knowledge	**Study**		**Control**	
	Pre-intervention (n=218) Freq (%)	**Post- intervention (n=218) Freq (%)**	**Beginning of study (n=218) Freq (%)**	**End of study (n=218) Freq (%)**
Good	74(33.6)	193(90.0)	98(45.8)	122(56.4)
Poor	144(66.4) **218(100)**	25(10.00) **218(100)**	120(54.2) **218(100)**	96(43.6) **218(100)**
χ^2 = 141.537; df = 1; p-value < 0.001*			χ^2 = 4.541; df = 1; p = 0.033*	

*Statistically significant

At baseline, the proportion of respondents with good knowledge in the study arm was 33.6%. This improved to 90.0% after intervention. In the control arm, the proportion also improved from 45.8% at the beginning of the study to 56.4% at the end of the study. The improvement in knowledge score was higher in the study group, but the percentage increase in both arms of the study were statistically significant (p <0.05).

Table 4 Participants' Attitude Score on Biomedical Waste Management by Study Status

	Study		**Control**	
Attitude	**Pre-intervention (n=218) Freq (%)**	**Post- intervention (n=218) Freq (%)**	**Beginning of the study (n=218) Freq (%)**	**End of the study (n=218) Freq (%)**
Positive	88(40.3)	168(77.8)	77(34.6)	83(37.7)
Negative	130(59.7) **218(100)**	50(22.2) **218(100)**	141(65.4) **218(100)**	135(62.3) **218(100)**
χ^2 = 62.315; df = 1; p-value < 0.001*			χ^2 = 0.422; df = 1; p = 0.516	

*Statistically significant

The proportion of respondents with positive attitude in the study arm improved from 40.3% before to 77.8% after intervention with a p-value less than 0.05. In the control, the proportion with positive attitude was 34.6% at the beginning of the study and improved to 37.7% at the end of the study with a p-value of 0.516, which was not statistically significant.

Table 5 Practice Score on Biomedical Waste Management by Study Status

	Study		**Control**	
Practice	**Pre-intervention (n=218) Freq (%)**	**Post- intervention (n=218) Freq (%)**	**Beginning of the study (n=218) Freq (%)**	**End of the study (n=218) Freq (%)**
Good	72(32.7)	189(88.3)	70(32.1)	76(34.9)
Poor	146(67.3) **218(100)**	29(11.7) **218(100)**	148(67.9) **218(100)**	142(65.1) **218(100)**
χ^2 = 139.160; df = 1; p-value < 0.001*			χ^2 = 0.371; df = 1; p-value = 0.543	

*Statistically significant

The proportion of respondents with good practice in the study arm increased from 32.7% pre-intervention, to 88.3% post-intervention, with a p-value less than 0.05(statistically significant). In the control arm, the proportion with good practice was 32.1% at the beginning of the study and 34.9% at the end of the study with a p-value of 0.543, which was not statistically significant.

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Table 6 Paired T Test for Scores from the Supervisory Check List by Study Status

Paired *t*-test	N	Mean	SD	Mean Difference	*T*	p-value
Study (Pair 1)						
Pre-intervention	30	7.40	2.408	-2.600	-1.960	0.122
Post intervention	30	10.40	2.000			
Control (Pair 2)						
Beginning of the Study	30	8.2000	4.08656	-0.200	-1.000	0.374
End of the Study	30	8.4000	3.78153			

SD= Standard Deviation

In the study arm (Table 6), the difference in means, which is an estimate of the amount by which the intervention changed the outcome on the average is -2.600 with a p-value of 0.122, which was not statistically significant. In the control arm, the mean difference is -0.200 with a p-value of 0.374. This was also not statistically significant.

➢ *Qualitative Component:*

The qualitative component of the study was meant to explore hands-on, detailed perspective of respondents on the knowledge, attitude and practice of BMWM and how interventions in the form of training, incentive and supportive supervision may influence HCW management in our setting.

➢ *Pre-Intervention*

The following are some of the findings from the FGD sessions held:

- *Knowledge of Biomedical Waste Management*

In most of the facilities used for this study, it was discovered that most of the participants had poor knowledge of the general principles of biomedical waste management. Majority of the discussants were of the opinion that, among other logistic inadequacies, lack of training or inadequate training, as the case may be, were responsible for the poor knowledge of BMWM. In one of the facilities studied, a 47year-old discussant, a community health practitioner, had this to say:

"*In this center most of us work based on the knowledge that we already have and on the basis of the directives or instructions given by superiors or management. We have not had any formal training on HCWM in my entire 12 years of service in this facility. There is no special pre-placement training of sanitary workers or cleaners after employment. Work is chiefly based on directives or instructions. There is no documented HCWM guideline here. Sometimes when we have confusion or arguments on waste management issues, we resort to the internet or take the final say from the doctor.*''

- *Attitude towards Biomedical Waste Management*

In other sessions, discussants were almost equally divided on whether waste handling should be the exclusive responsibility of the hospital attendants or the sanitary staff. Some opined strongly that every staff is supposed to stick to his or her job description as enshrined in the terms of employment. That proper pre-placement training ought to be given to the cleaners and sanitary staff and to that extent, waste handling should be their exclusive duty. Others felt very strongly too, that all health care staff involved in waste generation ought to be involved in waste management/handling. They were of the view that waste sorting by those who generate them at the point of waste generation into designated waste bags will make the entire process more effective and safer for health care staff and patients.

➢ *Post-Intervention*

In respect of the knowledge of, attitude to and practice of BMWM, almost all the discussants in the study arm expressed satisfaction with the mode and quality of intervention at the post-intervention FGDs. They all agreed that there was need for regular training of HCWs on the principles of HCWM, establishment of incentive schemes and routine supportive supervision. Most of the participants expressed the fact that they were motivated and inspired by the intervention.

IV. DISCUSSION

In this study, the mean age group of the study participants was 33.30(±8.97). This is in keeping with a similar study in Abakaliki, Southeast Nigeria, where the mean age group of study participants was 33.40(±8.30).[12] This is however, lower than a similar study in Ethiopia.[13] More females (50.80%) than males participated in this study. This is also in disagreement with the findings from a study in Enugu, where more male respondents participated[14] and another study in Yenagoa, where male respondents were also more (57.5%).[15] In a similar study in Thailand, more females participated (87.2%).[16] Majority of the participants had tertiary education. This may be due to the fact that tertiary education is usually a pre-requisite for the employment of most of the workers in our health care facilities. This is in tandem with the study in Enugu (96.7%),[14] but out of tune with the study in Yenagoa,[17] in which secondary education was most predominant (52.5%).

Adequate knowledge is vital for appropriate BMWM practice.[18] The importance of good knowledge of and efficient management of BMW and its implication on health and environmental safety cannot be over-emphasized.[19,20] However, in this study, only 33.6% of the study participants had adequate knowledge score before intervention. This does not agree with a study done at a Lassa treatment centre in south eastern Nigeria, which gave a pre-intervention knowledge score of 41.5%,[21] which is similar to another work done in Sri Lanka which reported 40.5% knowledge score.[22] The poor knowledge score in this study pre-intervention, may

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not be unconnected to the lack of enforceable healthcare waste management guideline or a domesticated bye-law, among several other barriers to efficient HCWM in Nasarawa State, the study area. The knowledge scores in the afore-mentioned studies are however, worse than the 56.6% reported in Ethiopia.[23] The fairly good report from the Ethiopian study may be a result of contextual factors because the study was carried out in a tertiary training facility where specialized services are offered and the likelihood of training and retraining of health care workers is also higher. In the index study, the knowledge score increased from 33.6% at baseline to 90% post-intervention. This may be a direct function of the intervention that was applied in the form of training, delivery of waste management incentives and serial supportive supervision. In more specific terms, majority of the respondents rightly categorized medical waste into sharps, biotechnology waste, liquid waste and chemical waste, among other categories. Before intervention, 97.2% of respondents correctly identified sharps, as a category of BMW. This increased to 100% post-intervention. In a similar vein, 78.9% of respondents and 67.0% of respondents respectively, identified chemical waste and biotechnology waste as waste categories before intervention. The knowledge again increased to 100% for chemical waste and 93.6% for biotechnology waste. This finding is in tandem with a similar work done in Lagos, Nigeria, which depicted better knowledge of BMW categories among health care workers after a training intervention.[24] In that study, about 75% of all the respondents rightly categorized both general and infectious waste. This was said to be due to the fact that they were trained, both in-house and outside their facilities on hospital waste management including the capacity-building sessions annually organized by Lagos waste management authority (LAWMA). The post-intervention finding is also in keeping with another study in India on training intervention in which 89.74% of respondents categorized BMW properly after intervention.[25]

In this study, 28.2% of participants correctly agreed that about 15% of HCW was hazardous in the pre-intervention phase of the study. In the post-intervention phase, the proportion of respondents who held this same position increased to 87% with a statistically significant difference. This is also in tandem with another work in Sudan, where the poor knowledge score (25%) recorded pre-intervention decreased to 10% post-intervention.[26] The findings were also consistent with another study in India, in which knowledge of the hazardous potential of medical waste increased from 25% pre-intervention to 78% post-intervention.[27] On the knowledge of sharps as a biomedical waste category and the means of disposal, in this study, 81.7% of respondents identified sharps containers as the receptacle for disposal of waste sharps pre-intervention. Post-intervention, all the respondents rightly identified sharps containers as the means of disposal of sharps waste. This is better than the finding from the study in Abakaliki,[12] but similar to the findings from similar studies in Pakistan[13] and India.[28,29,30]

Biomedical waste segregation is the most critical step in proper HCW management, and it should be done at the point of generation using colour-coded bins.[31] All hazardous wastes should be segregated at the point of generation.[32-35] In this study however, only 81.7% of respondents were aware of the need for waste segregation at the point of generation. This is lower than the findings from a study in Ethiopia which reported 88.2%.[24] From the fore-going, it is clear that pro-active intervention in health care waste management have salutary effects on the knowledge of BMWM. Based on the series of findings above, it is also clear that the place of interventions like clinical mentoring or training, among other modalities, as veritable means of building capacity in respect of health care waste management is pre-eminent. Among other factors, the absence of a unified national health care waste management plan, improper monitoring and supervision by the regulatory agencies, lack of capacity building programs and poor attitude towards health care waste management are some of the possible reasons for the variations in knowledge of HCWM noted in different centers, even within the same country. This opinion was corroborated by some of the findings from the FGD sessions. In her contribution in one of the sessions, one of the female discussants who is a sanitary worker had this to say:

"In this facility, am sorry to say, our management has little regard for personal protective equipment. Most of the big leather gloves that we use are worn out and we have never had any training on medical waste management. The big plastic waste bin outside the hospital supplied by our licensed waste evacuator is leaky because there are numerous holes on it. The holes were deliberately created to discourage thieves from stealing it. It is therefore a smell nuisance especially after rain. A neighbor who resides directly opposite the hospital once threatened to sue the hospital on this account."

In the current study, the proportion of respondents with positive attitude in the study arm improved significantly from 40.3% before to 77.8% after intervention. This improvement in attitude of respondents towards BMWM was probably a direct effect of the intervention instituted. In contrast with the current study, a study in Egypt showed improvement of 30.6% in positive attitude post-intervention from 11.2%.[36] In the study in Ethiopia, there was no statistically significant difference between the attitudes of all the groups. Attitude change of interns towards BMW management issues in the post-intervention phase was not significant.[28] This, the researchers believed, could be explained by the fact that a usually longer time period is required to properly assess attitude change. To the five likert-scale attitude question of, "Disposal of hospital waste along with municipal waste is almost inevitable in our environment", there were multiple divergent responses. Majority of the respondents agreed with this notion. This was also mirrored by the findings from the FGD sessions. Some discussants argued that in its present state, our health system lacked the logistic wherewithal to cope with the cost implications of meticulous waste segregation, on-site treatment and final disposal. They are of the opinion that because of our economic reality, most facilities, for example, cannot even afford a standard incinerator, let alone, the implications of sustainable maintenance of an incinerator. A discussant also said that licensed commercial waste evacuators are poorly supervised,

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given the manner in which they handle hospital waste. In his words:

"The waste evacuators use the same truck to recover domestic waste from residential homesteads and healthcare waste from health care facilities. The operators of the company that service our health facility usually wear protective booths and hand gloves only. I have never seen them with protective gowns, goggles or face mask."

In tandem with the current study, a similar intervention study in India, showed a statistically significant difference in the attitude of respondents pre- and post-intervention.[36] An intervention study in Pakistan also portrayed significant improvement in the attitude of the health care staff towards the management of BMW post-intervention.[37]

To get it right in respect of optimal management of HCWs, the practice must conform to a large extent with the standard guidelines.[38] In this study, the proportion of respondents with good practice increased from 32.7% pre-intervention to 88.3% post-intervention with a statistically significant difference (p=0.022). In a similar vein practice wise, the proportion of respondents who discard infectious waste in yellow bins increased from 56.9% pre-intervention to 95.0% post-intervention. Those that disagreed with the use of incinerators for disposal of waste sharps decreased from 42.2% pre-intervention to 14% post-intervention. The reason for this remarkable improvement may not be unconnected to the interventions given in the form of clinical mentoring and supportive supervision. In a similar manner, a study in Enugu, southeast Nigeria, reported that 72% of respondents discard sharps in sharps containers always.[34] This is in agreement with another study on HCWM in India.[39] In a similar study in Ethiopia, 77.4% of the study participants had adequate practice score. 77%, 66.9% and 83.4% of the study participants discard general, infectious and sharps wastes in the black bin, yellow bin and sharps containers respectively.[28] Improvement in practice levels of 90% was also reported in South Africa in another study,[40] but poorer practice levels were found in studies in Egypt[41] and Gaza.[42] The findings from this current study are consistent with many other studies on knowledge, attitude and practice of health care waste management.[43-46] The variations noted above may be a result of contextual factors depending on the setting in which the studies were carried out. Some of the studies were done in primary health care settings, others in secondary care facilities and others in tertiary health care facilities. There was however, no statistically significant difference in the findings from the supervisory check list in both arms of the study, even though the mean difference from the two-tailed hypothesis was higher in the study arm compared to the control arm. Among other possible explanations, the reason may not be unconnected with the fact that the follow-up period of 26 weeks may be too short to gauge enduring changes especially in attitude.

V. CONCLUSION AND RECOMMENDATIONS

This study, an intervention study meant to determine the effect of mentoring and supportive supervision on biomedical waste management, showed good knowledge score among only 33.6% of respondents, pre-intervention; positive attitude score among only 40.3% of respondents, pre-intervention and good practice score among only 32.7% of respondents, pre-intervention. Following meticulous mentoring and routine supportive supervision of participants in the study arm, the proportion of respondents with good knowledge score increased to 90.0%. The proportion of respondents with positive attitude score also increased to 77.8% and good practice score increased to 88.3%. The differences were statistically significant in all cases. There was little or no difference in the knowledge of, attitude to and practice of BMWM in the control arm, at the beginning compared to the end of the study.

➢ *The Following Recommendations are therefore based on the Findings from this Study:*

- Because of the hazardous potentials of BMW and its far-reaching implications on human, animal and environmental health, there is the need for government to prioritize HCWM and in the process establish a system of routine capacity building, incentive schemes for HCWM and routine supportive supervision within the confines of a proactive regulatory framework.
- There is the need for collaboration between the public and private sector to evolve innovative funding mechanisms, to make resources available on a sustainable basis, for the establishment of waste management incentive schemes for HCFs.

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➢ *Conflict of Interest*

The authors hereby declare that there's no conflict of interest in the course of this research work.

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