International Journal of Medical and Health Research
ISSN: 2454-9142; Impact Factor: RJIF 5.54
Received: 10-05-2019; Accepted: 14-06-2019
www.medicalsciencejournal.com
Volume 5; Issue 7; July 2019; Page No. 56-62

Development and assessment of improvement program for biomedical waste management in primary health care units of Ismailia district, Egypt

Nesreen F Mohamed[1*], Sobhy A Sobhy[2], Abeer E Mohamed[3], Rasha M Farghaly[4], Mostafa AF Abbas[5], Lamiaa E Fiala[6]

[1] Community Medicine Department, Faculty of Medicine, Port Said University, Egypt
[2, 4, 5, 6] Department of Public Health, Community, Environment and Occupational Medicine, Faculty of Medicine, Suez Canal University, Egypt
[3] Medical Microbiology and Immunology Department Faculty of Medicine, Suez Canal University, Egypt
[6] Department of Health Sciences, Faculty of Health & Rehabilitation Sciences, Princess Noura Bint Abdulrahman University, Riyadh, Saudi Arabia

Abstract
Background: Biomedical waste is a neglected public health problem. Health care workers are the key for its management, so training is a must for an ideal performance.
Aim: This study aimed to assess the current biomedical waste management process and the knowledge, attitude and practice of health care workers, develop and evaluate the effect of an improvement program.
Subjects and Methods: pre-post intervention study was conducted at the fifteen PHC units affiliated to Ismailia health district and 307 healthcare workers for initial assessment and the development of the program. Then four PHC units and 80 HCWs participated for the implementation and evaluation of the program. Three Data collection tools were employed, the Individualized Rapid Assessment Tool (IRAT), a self-administered questionnaire to assess knowledge and attitude and an observation checklist for the practice.
Results: The total average aggregate score percentage when rated using the I-RAT was 51% per urban and 47% for rural PHC unit. There are significantly higher correct knowledge mean percentage in young age than old age (p=0.013), according to their job and their departments (<0.001). Regarding the correct attitude there was a statistically significant difference between age, job, and department. As for practice, there are statistically significant differences between job and years of experience. The overall knowledge, attitude and practice mean percentage increased significantly in all the selected PHC units before and after the intervention with a p value (P<0.001).
Conclusions: Training had a positive impact on staff knowledge, practices and attitudes.

Keywords: knowledge, attitude, practice, intervention program

Introduction

The term biomedical waste (BMW) is the waste generated during the diagnosis, treatment or immunization of human beings or animals or in research activities or in the production or testing of biologicals and is contaminated with human fluids [1].

Biomedical waste management (BMWM) is the process that ensures proper health care facility (HCF) hygiene and safety for the health care workers (HCWs) and communities. It includes planning and procurement, construction, staff training and behavior, proper use of tools, machines and pharmaceuticals, proper disposal methods inside and outside the HCFs, and evaluation. It includes all activities involved in waste generation, segregation, transportation, storage, treatment and final disposal [2].

According to the WHO 80% of clinical wastes are non-hazardous comparable to domestic waste, 15% are infectious and the remaining 5% is made-up of sharps (1%), toxic chemicals and pharmaceuticals (3%) and genotoxic and radioactive waste (1%) [3].

The sixth target of the eleventh Sustainable Development Goal (SDG) emphasizes that countries should by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management [4].

The amount of waste generated depends on various factors like type of HCF, specializations, proportions of reusable items used and proportion of patients treated per day and the type of procedures done [5].

After the implementation of the National Health Insurance (NHI) system, HCFs have continually been improving the quality of medical treatment, and accepting more patients than before, thus resulting in an increased amount of workable HCF waste [6].

Egypt's progress towards universal health coverage (UHC) has been stimulated recently through the approval of Social Health Insurance (SHI) law. The new law has been approved by the government and parliament and authorized by the president for initiating application [7].

There are about 59 million HCWs around the world, ranging from direct care providers to BMW handlers, these large numbers of people are at risk of occupational hazard [8].

According to World Health Organization, the human component is more important than the technology alone.

Any system of biomedical waste management that is operated by well-motivated staff can provide more protection for the staff, patients, and the public than an expensive or sophisticated system that is managed by staff who do not understand the risks and the importance of their contributions [9].

Literature review showed little available information that describes the actual practice of handling BMW in primary healthcare (PHC) units.

Thus, the present intervention study was designed to improve knowledge, attitude and practice skills for BMWM among HCWs in some selected PHC units of Ismailia district, Egypt, with a pre- and post-improvement program assessment.

Objectives of the study

1. To assess the current biomedical waste management process and the knowledge, attitude and practice of health care workers in Ismailia district primary health care units.
2. To identify gaps for improvement in the biomedical waste management
3. To develop and evaluate the effect of an improvement program on biomedical waste management

Subjects and Methods

Study Design Pre-post intervention design was conducted.

Study Setting and population

The study was conducted in the fifteen primary health care units affiliated to the Ismailia health district. The study included 307 HCWs participants for initial baseline assessment. Then four PHC units, including 80 HCWs that had the least individualized rapid assessment tool (IRAT) score percentage were recruited for the implementation and evaluation of the program.

The estimated sample size was 72 health care workers.

Sampling method

A comprehensive sampling method was used for initial baseline assessment and a purposive sampling method was selected for the implementation and evaluation of the improvement program at four selected units that had the least score.

Data collection Tools

Data collection was done using three tools:

The first data collection tool is the Individualized Rapid Assessment Tool (IRAT) that was used for the rapid assessment of the current situation of biomedical waste management at the PHC units under study.

It takes into account biomedical waste management organizational structure, policy and planning, training, occupational health and safety, monitoring, periodic evaluation and corrective action, financing, segregation, waste generation, collection, handling, labeling, posters or signage, transport inside the facility, storage, treatment, waste disposal and wastewater management.

The tool results in an overall score (135) that can be used to compare and rank PHC units for the purpose of prioritizing interventions and identifying possible areas for improvement. The score was converted into percentage. Then the primary health care units were further categorized as 0-25% very poor, 26-50% poor, 51-75% good, and 76-100% excellent [10].

The second data collection tool was a self-administered Health care workers questionnaire that was developed by the researcher and is based on scientific literature [11, 12, 13, 14].

It consists of three main parts: 1st part involved questions about socio demographic characteristics, 2ndpart: assess health care workers' knowledge about waste management and included 24 items, 3rdpart: consisted of seven items to assess their attitude and were measured on a 3-point scale for a response (agree, neutral and disagree).

The third data collection tool was an observation checklist to evaluate the practice.

Improvement program development and implementation

After analyzing the collected data, gaps for improvement were identified, and then a BMWM improvement program was developed and implemented. The intervention program components were: the development and distribution of an informational booklet, the preparation and implementation of an educational training program consisted of five sessions.

Re-assessment and evaluation was done and the results were analyzed by comparing the difference between the first and the second assessment.

Data management: The statistical analysis of data was done by using SPSS program statistical package for social science version 23.

Ethical considerations: all ethical considerations were taken into account during the conduction of this study.

Results

The study results revealed that the aggregate score percentage when rated using the I-RAT to evaluate the PHC units' current BMWM practices ranged from as low as 44.6 % to 55% with total average score percentages 51% for urban PHCs and ranged from as low as 39.9%to 52.4% with total average score percentage was 47% for the rural as shown in figure 1 and 2.

Table 1 shows socio-demographic characteristics of health care workers (HCWs) where females were significantly more in urban than rural PHC units (84.8% vs. 75.6 % with p value= 0.04).

Physicians formed a greater proportion (21.2%) among the HCWs respondents in urban compared to rural PHC units (8.9%). On the other hand, nurses were greater in rural than urban PHC units (63.4%vs. 48.4%). The job categories were significantly different between study groups (p value= 0.04).

The mean of years of experience of study participant was 19.14 ±9.7and was statistically different between study groups (p value= 0.03).

Table 2 shows that the knowledge correct response percentage was the highest for the necessity of marking hazardous BMW by bio-hazard symbol in both urban and rural PHC units (95.1% for urban and 94.8% for rural PHC units).The lowest response was for the most dangerous gas emitted from BMW incinerators (17.3%) and it was statistically significant higher in the HCWs of the urban

than rural PHC units (21.7% vs.10.6% with p = 0.011).

Table 3 shows that the correct attitude response was the highest for the extreme importance of safe disposal of BMW in prevention of infection transmission in both urban and rural PHC units (100% for urban and 99.2% for rural PHC units). The lowest correct attitude response was for the responsibility of the institution and not the individual regarding the safe BMWM where only 34.8 % of urban and 32.5% of rural PHC units HCWs disagree with the statement.

Table 4 shows that the correct practice percentage was the highest for the proper disposal of sharps in puncture proof containers in both urban and rural PHC units (83.2% and 83.7% respectively).

The lowest correct practice percentage was for following the correct procedures to deal with BMW spillages in both urban and rural PHC units (35.8% and 36.5%respectively).

Figure3 shows that the overall knowledge, attitude and practice mean percentage increased significantly in all the selected PHC units before and after the intervention with p value (P<0.001).

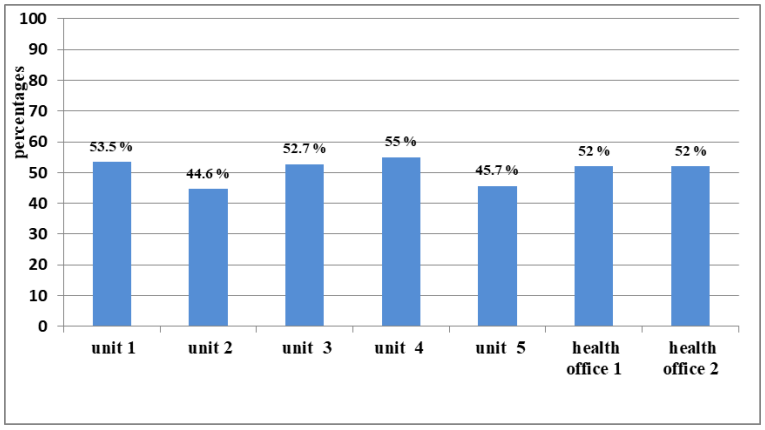

Fig 1: I-RAT for current biomedical waste management practices aggregate score percentage per urban PHC unit.

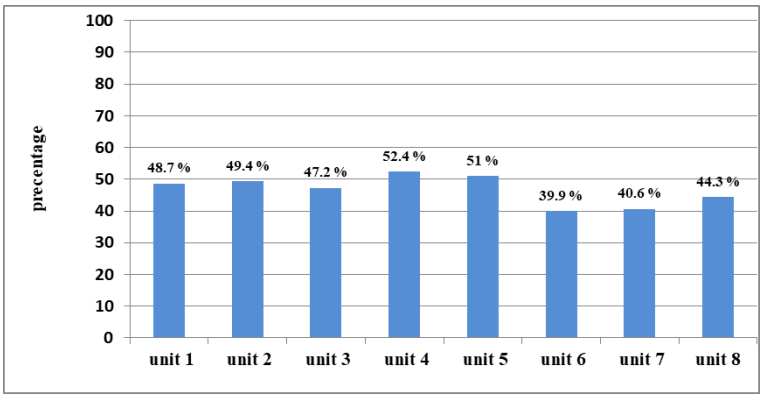

Fig 2: I-RAT for current biomedical waste management practices aggregate score percentage per rural PHC unit.

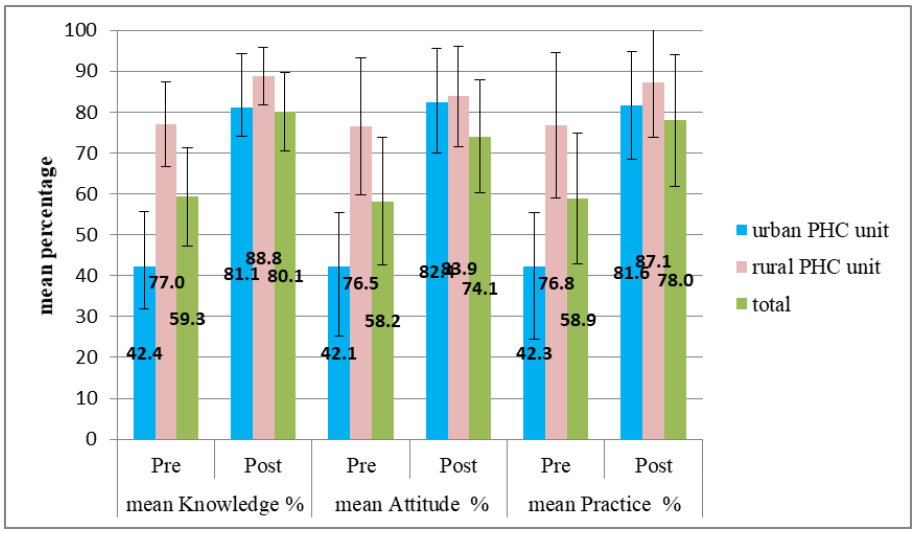

Fig 3: Comparison of mean percentages of correct answer regarding knowledge, attitude and practice pre and post intervention program according to type of PHC unit among the studied participants in the selected PHC units (n=80).

Table 1: Socio-demographic characteristics of health care workers in urban and rural primary health care units (n= 307)

Characteristics	Urban PHC units (184) No (%)	Rural PHC units (123) No (%)	Total No (%)	*p*-value
Age (years)				
>30	32 (17.4)	20 (16.3)	52 (16.9)	0.855¥
30 -	69 (37.5)	50 (40.7)	119 (38.8)	
<40	83 (45.1)	53 (43.1)	136 (44.3)	
Mean age ± SD	39.8 ±9.3	39.47±7.8	39.71± 8.7	0.697¶
Gender				
Female	156 (84.8)	93(75.6)	249(81.1)	0.040*¥
Male	28(15.2)	30(24.4)	58(18.9)	
Job category				
Physician	39 (21.2)	11(8.9)	50(16.3)	0.040*¥
Dentist	17 (9.2)	13(10.6)	30(9.8)	
Nurse	89 (48.4)	78(63.4)	167(54.4)	
Laboratory technician	11 (6)	7(5.7)	18(5.9)	
Sanitarian	10 (5.4)	3(2.4)	13(4.2)	
Cleaning worker	18 (9.8)	11(8.9)	29(9.4)	
Departments of work				
Family medicine clinic	52 (28.3)	35 (28.5)	87 (28.3)	0.161¥
Dental clinic	27 (14.7)	21 (17.1)	48 (15.6)	
MCH clinic•	22 (12)	19 (15.4)	41 (13.4)	
Vaccination	23 (12.5)	9 (7.3)	32 (10.4)	
Family planning	15 (8.2)	9 (7.3)	24 (7.8)	
Laboratory room	11 (6)	7 (5.7)	18 (5.9)	
Emergency room	3 (1.6)	9 (7.3)	12 (3.9)	
Others••	31 (16.8)	14 (11.4)	45 (14.7)	
Years of experience				
< 10	51(27.7)	22(17.9)	73(23.8)	0.030*»
≥ 10	133(72.3)	101(82.1)	234(76.2)	
Mean years ± SD	18.77±10.3	19.69 ±8.7	19.14 ±9.7	0.401¶

**Statistically Significant at 95%. P-values < 0.05*

¥ *Chi-square test is used.*

¶*student t test is used.*

» Fisher exact test is used. • Maternal and child health clinic.

••others included health office doctors, sanitarians and cleaning workers.

Table 2: Percent of correct answers of HCWs ' knowledge about biomedical waste management in urban and rural PHC units (n=307)

Knowledge items	Urban (184) No (%)	Rural (123) No (%)	Total No (%)	*p*-value
1. Definition of disinfection	58(31.5)	48(39)	106(34.5)	0.175¥
2. Percentage of total waste and hazardous waste	43(23.4)	20 (16.3)	63(20.5)	0.131¥
3. Biomedical waste hazards	142(77.2)	87(70.7)	229(74.6)	0.204¥
4. Biomedical waste segregation	135(73.4)	83(67.5)	218(71)	0.265¥
5. Hand hygiene as the most effective infection control methods compared to simple cost	111(60.3)	81(65.9)	192(62.5)	0.327¥
6. Antiseptics used to clean the environment	127(69)	62(50.4)	189(61.6)	0.001*¥
7. Proper disposal of ash resulting from BMW incineration	117(63.6)	83(67.5)	200(65.1)	0.483¥
8. Diseases transmitted by BMW contaminated with blood	91(49.5)	42(34.1)	133(43.3)	0.008*¥
9. The necessity of Bio-hazard symbol	175(95.1)	116(94.3)	291(94.8)	0.757¥
10. The first step taken when a spill occurs	46(25)	42(34.1)	88(28.7)	0.082¥
11. Duration of HBV survival at room temperature.	79(42.9)	40(32.5)	119(38.8)	0.066¥
12. The most dangerous gas emitted from BMW incineration.	40(21.7)	13(10.6)	53(17.3)	0.011*¥
13. Methods of BMW final disposal.	80(43.5)	50(40.7)	130(42.3)	0.623¥
14. The weakest microbes resistant to antiseptics.	83(45.1)	48(39)	131(42.7)	0.291¥
15. The lowest temperature of the incinerator 1st chamber	33(17.9)	22(17.9)	55(17.9)	0.991¥
16. The lowest temperature of the incinerator 2nd chamber	30(16.3)	30(24.4)	60(19.5)	0.080¥
17. The nature of the output of the shredding and sterilization devices for BMW	77(41.8)	56(45.5)	133(43.3)	0.524¥
18. The least distance between the chimney of the incinerator and the residential places	98(53.3)	62(50.4)	160(52.1)	0.624¥
19. Maximum storage time for biomedical waste	42(22.8)	36(29.3)	78(25.4)	0.204¥
20. Characteristics of BMW temporary storage area	122(66.3)	74(60.2)	196(63.8)	0.272¥
21. The places on which the Bio-hazard symbol is placed	160(87)	93(75.6)	253(82.4)	0.011*¥
22. The competent authority to issue a permit for the circulation of hazardous BMW	66(35.9)	41(33.3)	107(34.9)	0.648¥
23. Definition of sterilization	87(47.3)	26(21.1)	113(36.8)	0.001*¥
24. Importance of vaccination with hepatitis B vaccine for hepatitis c patients	82(44.6)	45(36.6)	127(41.4)	0.164¥

*Statistically Significant at 95%. P-values < 0.05

¥ Chi-square test is used.

Table 3: Health care workers' attitude towards biomedical waste management in urban and rural Ismailia district primary health care units (n=307)

Attitude items	Urban (184) No (%)	Rural (123) No (%)	Total No (%)	*p*-value
Safe disposal of BMW is extremely important to prevent infection transmission.				
Agree	184 (100)	122 (99.2)	306(99.7)	0.400»
Neutral	0(0)	1(0.8)	1(0.3)	
Disagree	0(0)	0(0)	0(0)	
Safe disposal of BMW is a priority of the health care unit.				
Agree	170 (92.4)	115 (93.5)	285 (92.8)	0.050¥
Neutral	11(6)	2 (1.6)	13 (4.2)	
Disagree	3(1.6)	6 (4.9)	9 (2.9)	
BMW management is a team work.				
Agree	170 (92.4)	112 (91.1)	282 (91.9)	0.032*¥
Neutral	12 (6.5)	4 (3.3)	16 (5.2)	
Disagree	2 (1.1)	7 (5.7)	9 (2.9)	
The safe BMWM increases the financial burden on the health care unit.				
Agree	52 (28.3)	38 (30.9)	90 (29.3)	0.685¥
Neutral	51 (27.7)	37 (30.1)	88 (28.7)	
Disagree	81(44)	48(39)	129(42)	
The safe BMWM is the responsibility of the institution and not the individual.				
Agree	96 (52.2)	75 (61)	171 (55.7)	0.125¥
Neutral	24 (13)	8 (6.5)	32 (10.4)	
Disagree	64 (34.8)	40 (32.5)	104 3.9)	
Wear personal protective equipment reduces the risk of infection				
Agree	176 (95.7	122 (99.2)	298 (97.1)	0.056»
Neutral	7 (3.8)	0 (0)	7 (2.3)	
Disagree	1 (0.5)	1(0.8)	2 (0.7)	
The safe BMWM is an additional workload				
Agree	40 (21.7)	33 (26.8)	73 (23.8)	0.515¥
Neutral	33 (17.9)	18 (14.6)	51 (16.6)	
Disagree	111 (60.3)	72 (58.5)	183 (59.6)	

*Statistically Significant at 95%. P-values < 0.05

¥ Chi-square test was used.

» fisher exact test was used.

Table 4: Practice of health care workers correctly performed regarding biomedical waste management in urban and rural Ismailia district primary health care units (n=307)

Practice Item correctly performed	Urban (184) No (%)	Rural (123) No (%)	Total No (%)	*p*-value
1. Use of appropriate personal protective equipment during handling of BMW	107(58.2)	87(70.7)	194(63.2)	0.025*¥
2. Wash hands after handling BMW	92(50)	69(56.1)	161(52.4)	0.294¥
3. The sharps containers and infectious waste bags are filled only 3/4th full	144(78.3)	107(87)	251(81.8)	0.052¥
4. Disposal of sharps in puncture proof containers	153(83.2)	103(83.7)	256(83.4)	0.892¥
5. Disposal of BMW(not sharps) in specified color coded containers	143(77.7)	93(75.6)	236(76.9)	0.668¥
6. Follow proper procedures for handling, loading and unloading coded BMW bags and containers	78(42.4)	55(44.7)	133(43.3)	0.687¥
7. Follow correct procedures to deal with BMW spillages.	68(37)	44(35.8)	112(36.5)	0.833¥

*Statistically Significant at 95%. P-values < 0.05

¥ Chi-square test is used.

Discussion

According to the United Nation Basel Convention the biomedical waste (BMW) is considered the second most dangerous wastes after nuclear wastes [15].

The WHO I-RAT was the main tool used to evaluate the PHC units' current BMWM practices on 16 domains. The present study results revealed that the aggregate score percentage when rated using the I-RAT ranged from as low as 44.6 % to 55% and 39.9%to 52.4%per urban and rural PHC unit respectively.

This finding was not in agreement with a report on the training needs assessment of HCWs on BMWM in Kenya which used the same tool and it revealed that I-RAT aggregate scores per visited facility were ranging from 60-80% [16].

Regarding training, the current study revealed that all PHC units did not have a written training program in BMWM. This is in agreement with a study conducted by Akum, 2014 [17]. who found that despite most of HCWs are claiming that there was training for workers in dealing with BMW; the hospital had no formal training programs. This was also was consistent with a survey of hospitals in Tanzania suggested that there was low knowledge of BMW among staff, use of untrained informal manual worker to handle BMW [18].

Other studies conducted by Kumar et al., 2016, [19]. and Abah and Ohimain, 2011, [20]. have also indicated regular training of HCWs on BMWM to have a great role on their practices.

The present study results showed that the correct knowledge response percentage was the highest for the necessity of marking hazardous BMW by bio-hazard symbol.

The lowest response was for the most dangerous gas emitted

from BMW incinerators (17.3%). This was not consistent with the study conducted by Mannapur et al., 2014 [21].

The current study results show a statistically significant difference between the urban and rural study participants in one attitude assessment item; waste management is a team work.) This was in consistent with the study conducted by Anand et al., 2016 [22].

In the present study it was found that the majority of HCWs (99.7%) agreed that safe disposal of BMW is extremely important to prevent infection transmission. This result was consistent with the study done in South Africa by Ramokate and Basu, 2009, [23]. and also in agreement with the study conducted by Yenesew et al., 2012 [24].

In the present study it was found that the majority of HCWs (93%) considered BMW as a priority of the health care unit, 24% thought that it is extra burden at work and 56% thought that safe BMWM is the responsibility of the institution not an individual responsibility. These findings were in agreement with Al Balushi et al., 2018 results [25].

The present study results revealed that the overall knowledge mean percentage increased significantly in all the selected PHC units before and after the intervention with p value (P<0.001) denoting significant difference in the level of knowledge between pre and post-test mean percentages. This was consistent with a study conducted by El-Sharkawy, 2009 [26].

Concerning the attitude mean percentages the present study results show significant increase in all the selected PHC units before and after the intervention with p value (P<0.001). This was also consistent with El-Sharkawy [26]. study results. The progress reached can be attributed to sensitizing the contributor to the problem that made them agree with many activities subsequently.

In the current study the practice mean percentages increased significantly in all the selected PHC units before and after the intervention with p value (P<0.001). This was in agreement with the results of a study conducted in the selected hospitals of Alexandria, Egypt by Hosny et al., 2018 [27]. The improvement in practice after intervention pointed to that the educational intervention was very valuable.

So the training and educational program have showed that a continuous education could improve the overall approach toward the BMWM. Many studies suggested that such trainings are very important [19, 28, 29].

The high significance of the improvement in the present study may be due to the full content of the educational training program, the attention of the study participants, use of appropriate regulations of adult learning and encouragement of questions and discussion.

Conclusion

From the current study findings, it was concluded that the baseline assessment using the individualized rapid assessment tool provides information that can be used to compare and rank PHC units for the purpose of prioritizing interventions and to identify possible areas for improvement.

The training program had a positive impact on staff knowledge, practices and attitudes. There was a significant improvement after attending the training program.

References

1. Park K. Park's textbook of preventive and social medicine. Jabalpur. Banarasidas Bhanot, 2011, 463.
2. World Bank. HNP group Tools and Guidelines the Care Waste Management Guidance Note, 2010.
3. World Health Organization (WHO) Health care waste management Available on the http://www.who.int/mediacentrefactsheets/Fs281/en/inex.html, 2011.
4. World Health Organization. World health statistics 2016: monitoring health for the SDGs sustainable development goals. World Health Organization, 2016.
5. Rajan R, Robin DT, Vandanarani M. biomedical waste management in Ayurveda hospitals–current practices & future prospectives. Journal of Ayurveda and integrative medicine, 2018.
6. Liao CJ, Ho CC. Risk management for outsourcing biomedical waste disposal–Using the failure mode and effects analysis. Waste management. 2014; 34(7):1324-9.
7. World Health Organization. Country cooperation strategy for WHO and Egypt. World Health Organization. Regional Office for the Eastern Mediterranean, 2018.
8. Aluko OO, Adebayo AE, Adebisi TF, Ewegbemi MK, Abidoye AT, Popoola BF. Knowledge, attitudes and perceptions of occupational hazards and safety practices in Nigerian healthcare workers. BMC research notes. 2016; 9(1):71.
9. Shah S, Mehta M, Mukherjee MD. Occupational Health Hazards Encountered at Health Care Facility and Medical College in India. American Industrial Hygiene Association, 2009.
10. Sapkota B, Gupta GK, Mainali D. Impact of intervention on healthcare waste management practices in a tertiary care governmental hospital of Nepal. BMC public health. 2014; 14(1):1005.
11. Egyptian Ministry of Environment. Health care waste management in Egypt – an instruction manual, 2015. (In Arabic) http:// www.mohp./Doc Lib10/dalel.pdf
12. Malini A, Eshwar B. Knowledge, Attitude and Practice of Biomedical waste management among health care personnel in a tertiary care hospital in Puducherry. Int J Biomed Res. 2015; 6(03):172-6.
13. Chartier Y, editor. Safe management of wastes from health-care activities. World Health Organization, 2014.
14. Hakim SA, Mohsen A, Bakr I. Knowledge, attitudes and practices of health-care personnel towards waste disposal management at ain Shams University Hospitals, Cairo, 2014.
15. World Health Organization. WHO. Healthcare waste and its safe management. Accessed online at, 2008. http://www. Health care e waste. org.
16. Ministry of Health, Republic of Kenya. Training Needs Assessment of Health Workers on Health Care Waste Management in Kenya, 2017.
17. Akum FA. An assessment of medical waste management in Bawku Presbyterian hospital of the upper east region of Ghana. Merit Research Journal of Environmental Science and Toxicology. 2014; 2(2):27-38.
18. Kuchibanda K, Mayo AW. Public health risks from mismanagement of healthcare wastes in Shinyanga municipality health facilities, Tanzania. The Scientific World Journal, 2015.
19. Kumar R, Somrongthong R, Ahmed J. Impact of waste

management training intervention on knowledge, attitude and practices of teaching hospital workers in Pakistan. Pakistan journal of medical sciences. 2016; 32(3):705.
20. Abah SO, Ohimain EI. Healthcare waste management in Nigeria: A case study. Journal of Public health and Epidemiology. 2011; 3(3):99-110.
21. Mannapur BS, Dorle AS, Ghattargi CH, Kulkarni KR, Ramdurg UY, Hiremath LD, *et al*. Impact of educational intervention on the knowledge of biomedical waste management among health care workers in a tertiary care hospital at Bagalkot City. Journal of Evolution of Medical and Dental Sciences. 2014; 3(19):5076-83.
22. Anand P, Jain R, Dhyani A. Knowledge, attitude and practice of biomedical waste management among health care personnel in a teaching institution in Haryana, India. Int J Res Med Sci. 2016; 4(10):4246-50.
23. Ramokate T, Basu D. Health care waste management at an academic hospital: knowledge and practices of doctors and nurses. SAMJ: South African Medical Journal. 2009; 99(6):444-5.
24. Yenesew MA, Moges HG, Woldeyohannes SM. A cross sectional study on factors associated with risk perception of healthcare workers toward healthcare waste management in health care facilities of Gondar Town, Northwest Ethiopia. International journal of infection control, 2012, 8(3).
25. Al Balushi AYMD, Ullah MM, Al Makhamri AA, Al Alawi FS, Khalid M, Al Ghafri HM. Knowledge, Attitude and Practice of Biomedical Waste Management among Health Care Personnel in a Secondary Care Hospital of Al Buraimi Governorate, Sultanate of Oman. Global Journal of Health Science. 2018; 10(3):70.
26. El-Sharkawy GF. Effect of an educational program about medical waste management on awareness of internship physicians in Zagazig University Hospitals. Zagazig Journal of Occupational Health and Safety, 2009, 2(1).
27. Hosny G, Samir S, El-Sharkawy R. An intervention significantly improves medical waste handling and management: A consequence of raising knowledge and practical skills of health care workers. International journal of health sciences. 2018; 12(4):56.
28. Freedman AM, Simmons S, Lloyd LM, Redd TR, Alperin M, Salek SS, Swier L, Miner KR. Public health training center evaluation: a framework for using logic models to improve practice and educate the public health workforce. Health promotion practice. 2014; 15(1_suppl):80S-8S.
29. Cozendey-Silva EN, da Silva CR, Larentis AL, Wasserman JC, Rozemberg B, Teixeira LR. Cross-cultural adaptation of an environmental health measurement instrument: Brazilian version of the health-care waste management• rapid assessment tool. BMC public health. 2016; 16(1):928.