Journal of Community Health (2019) 44:284–291
https://doi.org/10.1007/s10900-018-0584-z

ORIGINAL PAPER

Knowledge and Practice of Health Workers about Healthcare Waste Management in Public Health Facilities in Eastern Ethiopia

Tadelle Doylo[1] · Tadesse Alemayehu[2] · Negga Baraki[3]

Published online: 19 October 2018

Abstract

Healthcare waste management (HWM) problems are growing with an ever-increasing number of hospitals, clinics, diagnostic laboratories, etc in Ethiopia. Health workers are one of the key personnel who are responsible for the proper management of healthcare wastes at any health facilities. However, this performance will depend the level of knowledge and practice regarding waste management. A facility based cross-sectional study design was applied on 400 health workers. All public health institutions inside Jigjiga town were included and the study participants were randomly selected from each health facility. Data were collected using pre-tested and self administered questionnaire. The collected data was analyzed using SPSS version 20. Multivariable logistic regression model was used to identify factors associated with knowledge and practice of health workers. Out of those involved in this study, 47.7% and 42.3% of respondents had good knowledge and good practice on healthcare waste management, respectively. Health workers in the age group of 35–44 years, nurses, midwifes, medical laboratory, were significantly associated with knowledge of health workers. On the other hand, only educational status was significantly associated with practice. In this study, both knowledge and practice of health workers about healthcare waste management was poor. To enhance both the knowledge and practice of health workers, on job training is recommended.

Keywords Health workers · Healthcare waste · Waste management · Knowledge · Practice

Background

Healthcare wastes (HCW) are wastes generated from healthcare facilities such as; hospitals, health centers, medical research centers, pharmaceutical manufacturing plants, pharmacies, blood banks, and home health care activities that are broadly categorized into general waste and hazardous waste [1]. Healthcare waste, medical waste, biomedical waste and hospital waste are terms which are used interchangeably [2]. Healthcare waste constitutes a special category of wastes because they contain potentially harmful materials and can cause ill health to those exposed to it.

Poor management of these wastes can jeopardize health workers, employees who handle healthcare waste, waste pickers, patients and their families, and the community at large to infection, toxic effects, and injuries, and risks of polluting the environment [3, 4]. The wastes generated from medical activities can also be hazardous, toxic and even lethal because of their high potential for disease transmission and injury [5]. Studies have indicated that the inappropriate handling and disposal of HCW poses health risks to health workers who may be directly exposed to infectious wastes and a higher risk of diseases such as hepatitis and HIV/AIDS [6, 7].

Management of health care waste is becoming an issue of growing concern in urban areas. In many developing countries, it is still indiscriminately disposed of and often mixed with municipal waste, thus causing serious health and environmental hazards [8]. If non-hazardous waste is mixed with hazardous waste, disposal should be employed as per regulations for hazardous waste [9] which is not the case for many low income countries such as Ethiopia. Infectious waste management has always remained a neglected public health problem in the developing countries, resulting in high

✉ Tadesse Alemayehu
tadessewon@yahoo.com; tadessewon@hotmail.com

[1] College of Health and Medical Sciences, Haramaya University, P.O.Box 235, Harar, Ethiopia

[2] College of Health and Medical Sciences, Haramaya University, P.O.Box 1517, Harar, Ethiopia

[3] College of Health and Medical Sciences, Haramaya University, P.O.Box 235, Harar, Ethiopia

burden of environmental pollution affecting general masses [10].

Adequate knowledge of those who are potential handlers of healthcare waste management (HWM) is important to understand its health hazards, proper technique and methods of handling the waste, and practice of safety measures which also be a base for its safe disposal [11]. There are however many reports in the developing countries where the level of knowledge and practice of healthcare waste management among health workers is generally low [7, 12–14].

In Ethiopia, HWM is given less attention than the other healthcare issues. As a result, the knowledge and practice of health workers about healthcare waste management didn't get sufficient attention. There is no sufficient recorded information on healthcare waste management and technologies and this hinders the planning for better management of healthcare wastes [15]. The success of healthcare waste management program rests on the knowledge and practice of health workers but there was no adequate study conducted on knowledge and practice of health workers towards healthcare waste management in public healthcare facilities in Ethiopia and the current study site. It was therefore with this understanding this study was designed to investigate the knowledge and practices health workers towards healthcare waste management in public health institutions (hospital and health centers) in eastern Ethiopia.

Materials and Methods

The study was conducted in Jigjiga town, capital of The Ethiopian Somali Regional State, in 2016. Facility based cross-sectional study design was used which includes all public health facilities (one hospital and three health centers) inside the town. 400 health workers were selected from the three health facilities by simple random sampling. The total sample was proportionally allocated to each health facilities based on the number of health workers each has at the time of data collection.

Data were collected using structured, pre-tested and self administered questionnaires. The instrument was prepared in English and no need of translation because all the health professionals were assumed that they can read and understand English language. Three diploma holder health professionals as data collection facilitators and two supervisors were employed. The facilitators and supervisors were given training for 2 days (1 day before and one after the pretest) on procedures, techniques and ways of collecting the data.

The questionnaires were checked for completeness, cleaned and edited. Complete items were coded and entered to EpiData software version 3.1 and transported to Statistical Package for the Social Science (SPSS) version 20 software packages for analysis. First descriptive statistics was analyzed to see the characteristics of the study population in relation to relevant variables. Two final models were constructed for the two outcome variables (measuring knowledge and practice of health workers). As a result, knowledge scores were calculated by giving 1 for correct answers and 0 for the wrong responses of each item. Similarly, practice scores were calculated by giving 1 and 0 for the other responses of each item. Total knowledge and practice scores were computed for each participant and then for all participants. Good knowledge and good practice were defined as correctly answering above the mean of the items and others were defined as poor knowledge and poor practice. Finally, the data was analyzed using multivariable logistic regressions to determine the effect of various factors on the outcome variables and to control possible confounding effect.

This study was carried out after the proposal got approval by Haramaya University, College of Health and Medical Sciences, the Institutional Health Research Ethics Review Committee (IHRERC). Data collectors explained to the respondents that the target of the study and the information obtained will be kept confidential and will be used for research purposes only. Data collection has proceeded after a written and signed consent from each respondent was secured. Before each question, the study objectives were clearly explained by clarifying the respondents the aim of study which was neither to evaluate the performance of the individual nor to blame anyone for weakness, rather to gather information and opinions that might lead to eventual improve the main problem of this study.

Results

Socio-demographic Characteristics

The study included 400 health workers with a response rate of 95.2%. The sex ratio (male-to-female) was 44.2:55.8. Most of the respondents, 183 (45.8%), were in the age group of 25–34 years old and 205 (51.2%) and 160 (40%) were found to have first degree and diploma, respectively. In addition to this, 176 (44%) and 169 (42.2%) were single and married, respectively. Regarding to the professional category of the respondents, almost half of them, 201 (51.4%) were nurses and majority, 132 (37.5%) have reported they were working in OPD. According to work duration of the health workers, 111 (27.8%) of them were worked for 2–4 years (Table 1).

Knowledge of Health Workers Towards Healthcare Waste Management

The level of knowledge was first computed from 10 knowledge related questions and score was generated for each

Table 1 Socio-demographic characteristics of health workers regarding healthcare waste management in Jigjiga town, eastern Ethiopia

Variables	Frequency	Percentage
Age (n = 400)		
< 25	151	37.8
25–34	183	45.8
35–44	48	12.0
45–54	16	4.0
> 54	2	0.4
Educational status (n = 400)		
Certificate	3	0.8
Diploma	160	40.0
First degree	205	51.2
Second degree	32	8.0
Current marital status (n = 400)		
Married	169	42.2
Single	176	44.0
Divorce	37	9.2
Widowed	17	4.3
Separate	1	0.3
Professional category (n = 391)		
Medical doctor	10	2.6
Health officer	87	22.3
Nurse	201	51.4
Midwifery	58	14.8
Medical laboratory	28	7.2
Anesthesia	7	1.8
Duration of employment (in years) (n = 400)		
< 2	83	20.8
2–4	111	27.8
5–9	101	25.2
10–14	65	16.2
15–19	25	6.2
> 20	15	3.8

respondent. The mean score (6.38) of 10 knowledge related questions was used as a cut of point to say good or poor knowledge after computing the score for each respondent from the questions. Out of the 400 participants, 188 (47%) had good knowledge and the rest 212 (53%) had poor knowledge on health care waste management (Table 2).

Perceptions of Health Workers Towards Healthcare Waste Management

The perception of health workers participated in this study was assessed with a couple of questions. Among the total respondent, only 130 (32.5%) perceived that healthcare waste is considered as useless and almost all, 99.8%, appreciated the importance of HWM (Table 3).

Table 2 Knowledge of health workers regarding healthcare waste management in Jigjiga town, eastern Ethiopia

Questions	Responses	Frequency	Percentage
How many categories of clinical waste do you know? (n = 400)			
	Less than five	212	53.0
	Five	188	47.0
What types of storage is used for infectious waste? (n = 400)			
	Strong black disposable plastic bags	104	26.1
	Safety box or yellow plastic bags	295	73.9
Amount of wastes put in the container (n = 400)			
	More than ¾ full	41	10.3
	¾ full or less than ¾ full	359	89.7
Do you know the presence of rules and regulations about HWM in Ethiopia? (n = 400)			
	No	256	64.0
	Yes	144	36.0
Mode of disposal for infectious waste (n = 400)			
	Burying	6	1.5
	Incinerator/burning	394	98.5
Is color-coding segregation important for healthcare wastes? (n = 400)			
	No	27	6.8
	Yes	373	93.3
Injuries need to be reported (n = 400)			
	No	38	9.5
	Yes	362	90.5
Matching correct method of handling wastes with their container color (n = 400)			
	No	19	4.8
	Yes	381	95.3
Does standard storage rooms required for healthcare wastes? (n = 400)			
	No	115	28.7
	Yes	285	71.3
Does waste management need annual plan? (n = 400)			
	No	281	70.3
	Yes	119	29.8

Practice of Health Workers on Healthcare Waste Management

The level of practice was first computed from 7 practice related questions and score was generated for each respondent. The distribution was normal during normality checkup. Then mean (4.29) was calculated and used as a cut of point to declare good or poor practice. Those whose score is greater than or equal to the mean were categorized as having good practice and those with score of less than the mean

Table 3 Perception of health workers regarding healthcare waste management in Jigjiga town, eastern Ethiopia

Variables	Responses	Frequency	Percentage
Perception on healthcare wastes (n = 400)			
	Useless	279	67.5
	Useful	130	32.5
Importance of healthcare waste management (n = 400)			
	No	1	0.3
	Yes	399	99.8
The need for follow up by the responsible body (n = 400)			
	No	216	54.0
	Yes	184	46.0
The need for penalty while violating the regulation (n = 400)			
	No	290	72.5
	Yes	110	27.5
The need for on job training (n = 400)			
	No	27	6.8
	Yes	273	93.3
Is HWM following a correct procedure in your HF? (n = 400)			
	No	260	65.0
	Yes	140	35.0
Do you understanding risks and health hazards of HCW? (n = 400)			
	No	25	6.2
	Yes	275	93.8
Do you understanding the risks of HCW to the environment? (n = 400)			
	Yes	27	6.8
	No	273	93.2
The need for collecting and transporting wastes daily (n = 400)			
	No	120	30.0
	Yes	280	70.0
Infectious wastes should be disposed in (n = 400)			
	Black bags and clear bags	45	11.3
	Yellow bags/sharps container	355	88.7
Color code for wastes to be autoclaved (n = 400)			
	Black/yellow/blue/white	103	25.8
	Red	297	74.2
Waste management is team work (n = 400)			
	Disagree	36	9.0
	Agree	364	91.0
Waste management is an extra burden (n = 400)			
	Disagree	347	86.8
	Agree	53	13.2
Color code for disposal of general waste (n = 400)			
	Red/yellow/blue	69	17.2
	Black	331	82.8

were categorized poor practice. Accordingly, 169 (42.3%) and 231 (57.7%) of the respondents had good and poor practice on healthcare waste management, respectively (Table 4).

Factors Associated with Knowledge Towards Healthcare Waste Management

In multivariable logistic regression analysis for which the candidates had been taken from the bivariate analysis with $p \leq 0.25$, the age group of 35–44 years, professional category

Table 4 Practice of health workers regarding healthcare waste management in Jigjiga town, eastern Ethiopia

Questions	Responses	Frequency	Percentage
Do you practice of recapping needles? (n = 400)			
	Yes	364	91.0
	No	36	9.0
Are you discarding sharps inside safety boxes? (n = 400)			
	Never	306	76.5
	Always	94	23.5
Frequency of use of gloves (n = 400)			
	Some times	103	25.8
	Always	297	74.2
Use of other PPE (n = 400)			
	Yes	9	2.3
	No	391	97.7
Practice following color-coding (n = 400)			
	No	11	2.8
	Sometimes	6	1.4
	Yes	383	95.8
Practice of segregating wastes (n = 400)			
	Yes	9	2.8
	No	389	97.8
Disposing of general and clinical wastes separately (n = 400)			
	Yes	15	3.8
	No	385	96.2

(nurses, midwifes, medical laboratory and anesthetist) had remand significantly associated with knowledge of health workers on healthcare waste management.

Accordingly, this study claimed that those who are in the age group between 35 and 44 years were [AOR = 6.83, 95% CI (1.30, 15.78)] more likely to have good knowledge towards healthcare waste management compared to those with the age group of ≥ 45 years. On the other hand, nurses [AOR = 3.42, 95% CI (1.33, 13.86)], midwifes [AOR = 1.53, 95% CI (1.07, 12.18)], medical laboratory technicians [AOR = 7.58, 95% CI (1.55, 19.54)] and anesthetists [AOR = 4.52, 95% CI (2.49, 7.80)] were more likely to have good knowledge towards healthcare waste management compared to medical doctors (Table 5).

Factors Associated with Practice on Healthcare Waste Management

On multivariable analysis, the only variable that remained significantly associated with practice of health workers was educational status. As a result, the odds of having good practice was almost three times more for those with educational status of diploma [AOR = 2.78, 95% CI (1.02, 7.59)] than second degree holders. Meanwhile those who have first degree [AOR = 2.55, 95% CI (1.01, 6.50)] were 2.5 times more likely to have good practice on healthcare waste management compared to those with second degree (Table 6).

Discussion

In this study, 47% respondents had good knowledge about healthcare waste management. This finding was higher than studies done in North West Ethiopia [16] and Tanzanian [17]. But, this finding was lower than a study finding from KwaZulu-Natal in South African [18]. These differences in the level of knowledge might be attributed because of the differences in basic professional and on job trainings among the health professionals in these areas.

The practice of healthcare waste management in this study, (42.3%), was found to be higher than a study conducted in Gondar town health facilities of northern Ethiopia, which was 31.5% [16]. And it was relatively lower than a result of another study conducted in Gondar University Hospital, Ethiopia [15] and studies in Nigeria [19] and South Africa [18]. The low level of practice shown in this study might be due to the already recorded poor knowledge about healthcare waste management. Because the level of knowledge was one of the factors which affects practice as seen in other studies [16, 18].

In this study, age group was found to be significantly associated with knowledge of healthcare waste management. As a result, age group of 35–44 years [AOR = 6.83, 95% CI (1.30, 15.78)] were almost 7 times more likely to have good knowledge about healthcare waste management compared to those with the age group of > 45 years. However, the finding in Kabul, Afghanistan, has shown that HCWs between 31 and 39 years of age had less knowledge compared with those 30 years and younger [20]. Normally as age increases, health workers will get more experiences and enhance their knowledge in their professional career [21].

Professional category was the other variable which has shown a statistical significance difference. Accordingly, nurses [AOR = 3.42, 95% CI (1.33, 13.86)], midwifes [AOR = 1.53, 95% CI (1.07, 12.18)], medical laboratory professionals [AOR = 7.58, 95% CI (1.55, 19.54)] and anesthetists [AOR = 4.52, 95% CI (2.49, 7.80)] were more likely to have good knowledge towards healthcare waste management compared to medical doctors. Different studies showed different result on the level of knowledge about HWM among the different categories of professionals. A study conducted in Egypt found that the percentage of physicians with satisfactory knowledge scores was significantly higher than among nurses [22]. Other study in South Africa has shown that nurses have high level of knowledge than other health professionals [18]. This disparity in knowledge of health workers may be due to the differences in curriculum of the basic professional

Table 5 Factors associated with knowledge of health workers regarding healthcare waste management in Jigjiga town, eastern Ethiopia

Factors	Frequency (%)	Knowledge		COR (95% CI)	AOR (95% CI)
		Good	Poor		
Sex					
Male	177 (44.3)	83	94	1.00	1.00
Female	223 (55.8)	105	118	1.01 (0.68, 1.50)	1.01 (0.63, 1.61)
Age (in years)					
< 25	151 (37.8)	77	74	5.20 (1.45, 18.71)*	6.52 (0.96, 44.18)
25–34	183 (45.8)	81	102	3.97 (1.11, 14.19)*	4.86 (0.80, 29.59)
35–44	48 (12.0)	27	21	6.43 (1.64, 25.16)**	6.83 (1.30, 15.78)*
> 45	18 (4.4)	3	15	1.00	1.00
Educational status					
Certificate	3 (0.8)	2	1	1.00	1.00
Diploma	160 (40)	75	85	0.44 (0.04, 4.96)	0.30 (0.02, 3.80)
First degree	205 (51.2)	93	112	0.42 (0.04, 4.65)	0.40 (0.03, 5.00)
Second degree	32 (8)	18	14	0.64 (0.05, 7.83)	0.84 (0.06, 12.04)
Marital status					
Married	169 (42.3)	77	92	1.00	1.00
Single	176 (44.0)	86	90	1.14 (0.75, 1.74)	1.13 (0.58, 2.21)
Divorced	37 (9.2)	16	21	0.91 (0.44, 1.87)	0.98 (0.43, 2.21)
Widowed	18 (4.5)	9	9	1.20 (0.45, 3.16)	1.23 (0.38, 4.16)
Professional category					
Medical doctors	10 (2.6)	1	9	1.00	1.00
Health officer	87 (22.2)	31	56	4.98 (0.60, 11.18)	6.34 (0.62, 15.73)
Nurse	201 (51.4)	102	99	9.27 (1.15, 24.55)*	3.42 (1.33, 13.86)*
Midwifery	58 (14.8)	28	30	8.40 (0.99, 10.63)	1.53 (1.07, 12.18)*
Medical lab	28 (7.2)	16	12	2.00 (1.33, 10.02)*	1.58 (1.55, 19.54)
Anesthesia	7 (1.8)	5	2	2.50 (1.61, 11.56)*	4.52 (2.49, 7.80)*
Working duration (in years)					
< 2	83 (20.8)	39	44	1.00	1.00
2–4	111 (27.8)	55	56	1.11 (0.63, 1.96)	1.03 (0.56, 1.90)
5–9	101 (25.2)	48	53	1.02 (0.57, 1.83)	1.33 (0.63, 2.85)
10–14	65 (16.2)	31	34	1.03 (0.54, 1.97)	1.03 (0.40, 2.61)
15–19	25 (6.2)	11	14	0.89 (0.36, 2.18)	1.68 (0.41, 6.87)
> 20	15 (3.8)	4	11	0.41 (0.12, 1.39)	1.47 (0.22, 9.79)

CI confidence interval, *COR* crude odds ratio, *AOR* adjusted odds ratio

*p-value < 0.05; **p-value < 0.01; ***p-value < 0.001

training between the categories and most importantly due to the proper and continuous on job training arranged for professionals.

In this study, health workers with educational status of diploma [AOR = 2.78, 95% CI (1.02, 7.59)] and first degree level [AOR = 2.55, 95% CI (1.01, 6.50)] were found to be more likely to have good practice on healthcare waste management compared to those with second degree. Similarly, level of education was found statistically significant with the practices with p-value < 0.05 [23]. However, another study conducted in Nigeria showed educational status of health workers didn't show a statistical significance difference with practice towards healthcare waste management [24].

Limitations of the Study

Due to small sample size, the confidence interval of some findings become wider which resulted in low precision during making inference to our target population. In this study, only public health facilities were included with a view that most of the people are utilizing such facilities. This might however reduce the maximum credibility of the research especially while generalizing the findings to the whole health workers in the region.

Table 6 Factors associated with practice of health workers regarding healthcare waste management in Jigjiga town, eastern Ethiopia

Variables	Frequency (%)	Practice		COR (95% CI)	AOR (95% CI)
		Good	Poor		
Sex					
Male	177 (44.3)	107	70	1.00	1.00
Female	223 (55.8)	124	99	1.22 (0.82, 1.82)	1.17 (0.77, 1.78)
Age (in years)					
< 25	151 (37.8)	88	63	1.43 (0.51, 4.02)	0.55 (0.51, 4.02)
25–34	183 (45.8)	102	81	1.6 (0.57, 4.42)	0.51 (0.11, 2.45)
35–44	48 (12.0)	29	19	1.31 (0.42, 4.09)	0.63(0.15, 2.67)
> 45	18 (4.4)	12	6	1.00	1.00
Educational status					
Certificate	3 (0.8)	2	1	1.79 (0.14, 22.7)	2.04 (0.15, 27.68)
Diploma	160 (40)	89	71	2.85 (1.17, 6.97)*	2.78 (1.02, 7.59)*
First degree	205 (51.2)	115	90	2.80 (1.16, 6.75)*	2.55 (1.01, 6.50)*
Second degree	32 (8)	25	7	1.00	1.00
Marital status					
Married	169 (42.3)	94	75	2.07 (0.71, 6.08)	1.52 (0.47, 4.90)
Single	176 (44.0)	101	75	1.93 (0.66, 5.65)	1.54 (0.42, 5.59)
Divorced	37 (9.2)	23	14	1.58 (0.46, 5.40)	1.00 (0.27, 3.70)
Widowed	18 (4.5)	13	5	1.00	1.00
Working duration (in years)					
< 2	83 (20.8)	51	32	2.51 (0.66, 9.59)	2.21 (0.34, 14.33)
2–4	111 (27.8)	65	46	2.83 (0.76, 10.60)	2.60 (0.41, 16.59)
5–9	101 (25.2)	52	49	3.77 (1.01, 14.17)*	3.89 (0.63, 24.02)
10–14	65 (16.2)	35	30	3.43 (0.88, 13.30)	3.71 (0.65, 21.24)
15–19	25 (6.2)	16	9	2.25 (0.50, 10.14)	2.42 (0.47, 12.41)
> 20	15 (3.8)	12	3	1.00	1.00
Knowledge					
Poor	212 (53)	118	94	1.00	1.00
Good	188 (47)	113	75	0.83 (0.56, 1.24)	0.83 (0.56, 1.24)

CI confidence interval, *COR* crude odds ratio, *AOR* adjusted odds ratio

*p-value < 0.05; **p-value < 0.01; ***p-value < 0.001

Conclusion and Recommendation

The majority of health workers in the area had poor knowledge and poor practice in applying healthcare waste management. Age (35–44 years), professional category (nurses, midwifes medical laboratory anesthetists) were significantly associated with knowledge of health workers on healthcare waste management. Level of education was significantly associated with practice of health workers on healthcare waste management. This low level of knowledge and practice of health workers towards healthcare waste management might be mainly attributed to poor training facilities. Regular on job refresher training and supervision of health workers are recommended to improve the poor knowledge and poor practice on healthcare waste management.

Acknowledgements Authors of this study would like to thank the respondents for their time and willingness to supply valuable information.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. WHO. (2005). *Management of solid healthcare waste at primary healthcare centers. A decision making guide*. Geneva: WHO. (**ISBN 92 4 1592475**).
2. Muhwezi, L., Kaweesa, P., Kiberu, F., & Eyoku, L., E (2014). Health care waste management in Uganda: A case study of Soroti

regional referral hospital. *International Journal of Waste Management and Technology, 2*(2), 1–12. (**Online**).
3. Nwachukwu, N. (2013). Health care waste management: Public health benefits, and the need for effective environmental regulatory surveillance in federal republic of Nigeria. In: A. J. Rodriguez-Morales (Ed.), *Current topics in public health*. Crotia: InTech.
4. Titto, E. (2012). Healthcare waste management: The current issues in developing countries. *Waste Management & Research, 30*(6), 559–561. https://doi.org/10.1177/0734242X12447999.
5. Radha, R. (2012). Assessment of existing knowledge, attitude, and practices regarding biomedical waste management among the health care workers in a Tertiary Care Rural Hospital. *International Journal of Health Sciences & Research, 2*(7), 14–19.
6. Moro, P. L., Moore, A., Balcacer, P., Montero, A., Diaz, D., Gomez, V., et al. (2007). Epidemiology of needlesticks and other sharps injuries and injection safety practices in the Dominican Republic. *American Journal of Infection Control, 35*, 552–559.
7. Abah, S. O., & Ohimain, E. I. (2012). Healthcare waste management in Nigeria: A case study. *Journal of Public Health and Epidemiology, 3*(3), 99–110.
8. UNEP. (2013). Policy Brief on Healthcare Waste. What, why and How, International Environmental Technology Centre.
9. Sapkota, B., Gupta, G. P., & Mainali, D. (2014). Impact of intervention on healthcare waste management practices in a tertiary care governmental hospital of Nepal. *BMC Public Health, 14*, 1005. https://doi.org/10.1186/1471-2458-14-1005.
10. Kumar, R., Somrongthong, R., & Shaikh, B. T. (2015). Effectiveness of intensive healthcare waste management training model among health professionals at teaching hospitals of Pakistan: A quasi-experimental study. *BMC Health Services Research, 15*, 81. https://doi.org/10.1186/s12913-015-0758-7.
11. Mathur, V., Dwivedi, S., Hassan, M. A., & Misra, P. P. (2011). Knowledge, attitude and practices about Bio-medical waste management among health care personnel: A cross-sectional study. *Indian Journal of Community Medicine, 36*, 143–145.
12. Ramokate, T., & Basu, D. (2009). Healthcare waste management at an academic hospital: Knowledge and practices of doctors and nurses. *South African Medical Journal, 99*(6), 444–445.
13. Shallini, S. (2010). Awareness about bio-medical waste management among healthcare personnel of some important medical centers in Agra. *International Journal of Environmental Science and Development, 1*(3), 251–255.
14. Uddin, M. N., Islam, M. R., & Yesmin, K. (2014). Knowledge on hospital waste management among senior staff nurses working in a selected Medical College Hospital of Bangladesh. *Journal of Waste Management*. https://doi.org/10.1155/2014/573069.
15. Mesfin, A., Worku, W., & Gizaw, Z. (2014). Assessment of health care waste segregation practice and as-sociated factors of health care workers in Gondar University Hospital, North West Ethiopia. *Universal Journal of Public Health, 2*(7), 201–207. https://doi.org/10.13189/ujph.2014.020703.
16. Muluken, A., Haimanot, G., & Mesafint, M. (2014). Healthcare waste management practices among healthcare workers in healthcare facilities of Gondar town, Northwest Ethiopia. *Health Science Journal, 7*(3), 315–326.
17. Kagonji, I. S., & Manyele, S. V. (2016). Analysis of health workers' perceptions on medical waste management in Tanzanian Hospitals. *Engineering, 8*, 445–459. https://doi.org/10.4236/eng.2016.87042.
18. Olaifa, A., Govender, R. D., & Ross, A. J. (2018). Knowledge, attitudes and practices of healthcare workers about healthcare waste management at a district hospital in KwaZulu-Natal. *South African Family Practice, 4*(1), 1–9.
19. Adogu, P. O. U., Ubajaka, C. F., & Nebuwa, J. E. (2014). Knowledge and practice of medical waste management among health workers in a Nigerian general hospital. *Asian Journal of Science and Technology, 5*(12), 833–838.
20. Fayaz, H. R., Higuchi, M., Hirosawa, T., Saker, M. A. B., Djabbarova, Z., & Hamajima, N. (2014). Knowledge and practice of universal precautions among health care workers in four national hospitals in Kabul, Afghanistan. *The Journal of Infection in Developing Countries, 8*(4), 535–542. https://doi.org/10.3855/jidc.4143.
21. Suchitra, J. B., & Lakshmi, D. N. (2007). Impact of education on knowledge, attitude and practice among various categories of health care workers on nosocomial infections. *Indian Journal of Medical Microbiology, 25*, 181–187.
22. Hakim, A., Mohsen, A., & Bakr, I. (2014). Knowledge, attitudes and practices of health-care personnel towards waste disposal management at Ain Shams University Hospitals, Cairo. *Eastern Mediterranean Health Journal, 20*(5), 347–354.
23. Kumar, R., Samrongtong, R., & Shaikh, B. T. (2013). Knowledge, attitude and practices of health staff regarding infectious waste handling of tertiary care health facilities at metropolitan city of Pakistan. *Journal of Ayub Medical College Abbottabad, 25*(1–2), 109–112.
24. Azuike, E. C., Adinma, E. D., Nwabueze, S. A., Azuik, E. D., Mbanuzuru, V. A., Epundu, U. U., et al. (2015). Healthcare waste management: What do the health workers in a Nigerian tertiary hospital know and practice. *Science Journal of Public Health, 3*(1), 114–118. https://doi.org/10.11648/j.sjph.20150301.30.