DOI: 10.7860/JCDR/2021/48532.15038

Original Article

Public Health Section

Medical Waste Management during Conflict: A Cross-sectional Study in Yemen

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ABSTRACT

Introduction: Proper handling and disposal of medical waste is an important issue, and a lack of awareness of medical waste management is a dangerous hazard for humans and the environment.

Aim: To determine the knowledge and practices of Healthcare Workers (HCWs) about medical waste management in Yemen.

Materials and Methods: A cross-sectional study was conducted among 337 HCWs in four main hospitals in Ibb city, Yemen, from November 2019 to May 2020. Knowledge and practice of medical waste disposal were assessed using a self-administered questionnaire to gather data from the respondents in Arabic language. Data analysis was performed using Statistical Package for the Social Sciences (SPSS) v. 25.0. Mann-Whitney, Chi-square, and Spearman and correlation tests.

Results: Most of the participants had a diploma (47.8%), occupation was nursing (41.2%), with less than five years of experience (50.7%). The study showed that respondents demonstrated good knowledge and practice about medical waste management. There was a moderate positive correlation between knowledge and practice domains. Occupation significantly influenced knowledge (p=0.001) and practice (p=0.002) of the participants. Type of hospital showed a statistically significant relation to knowledge (p=0.001). Education significantly influenced the knowledge (p=0.030) of the study participants.

Conclusion: Occupation, type of hospital and education level are the factors which significantly influenced the knowledge of Yemeni nurses. The contents of education should be focused on medical waste management among HCWs.

Keywords: Biowaste management, Healthcare workers, Knowledge, Practice

INTRODUCTION

Medical waste represents an alarming global health challenge. Hospitals, clinics, blood banks and laboratories produce Several types of medical wastes such as human tissue, blood, body fluids, excretions, drugs, pharmaceutical products, swabs, dressings, syringes, needles and other sharp instruments, which can cause infection to those who come in close contact with it [1]. Approximately, 15% of medical waste is listed as hazard, including toxic, infectious and radioactive materials. For instance, 16 billion injections are used yearly, and not all syringes and needles are discarded safely. This increases the incidence of injuries and infections. According to the World Health Organisation (WHO), there are numerous challenges associated with this problem, including a lack of awareness and training of medical waste management. Furthermore, absence of waste management and disposal systems, insufficient human and financial resources and the low priority are given to these issue makes matters worse [2]. Therefore, it is important to safeguard, both safety and health, of patients, HCWs and the public against the risk posed by medical waste.

Studies that have been conducted in this regard reported that lack of sufficient knowledge and lack of facilities are important factors in contributing to the inadequate medical waste disposal practices among HCWs [3-5]. A study from the Arabic region conducted in Jordan showed that HCWs have less appropriate practices in handling, storage and disposal of medical waste [6]. In Yemen, a study showed that there was a poor awareness about medical waste risks and safe handling procedures among hospital administrators [7]. While there is a greater global awareness of the hazards and effective management strategies among health professionals, the level of awareness in Yemen is found to be inadequate due to gaps between knowledge and practice when it comes to medical waste management. These gaps are due to local culture and hospital settings.

Therefore, the aim of this study was to assess the knowledge and practice related to medical waste management in Yemen.

MATERIALS AND METHODS

The present study was a cross-sectional study which was carried out at four main hospitals in Ibb city, Yemen namely: Al-Manar, Al-Noor, Al-Thawrah and Naser Hospitals from November 2019 to May 2020. Taiz University in Yemen granted ethical approval for the study (TU/2021-2001). Prior performing fieldwork, hospital management gave their written consent. Before answering the questionnaires, each participant gave their verbal consent. Each set of questionnaire consists of the title of the study, a full explanation about the study objective, expected outcomes, the nature of voluntary participation, and the maintenance of confidentiality and privacy.

Inclusion criteria: All participants, in all departments of the main hospitals, who were in direct and indirect contact with medical wastes and those who accepted to participate.

Exclusion criteria: All HCWs who were on temporary contract, those working for less than one week at given period in the unit, participants who were in the night shift were excluded. Participants who were unwilling to participate in the study and those who wished to discontinue their participation were allowed to do so without any restriction.

Sample size calculation: The following equation was used to calculate the sample size:

$$n=\frac{N\times p(1-p)}{[N-1\times(d^2\div z^2)]+p(1-p)}$$

Where; n: Sample size, N: Population size, z: Confidence level, d: Error proportion, p: Probability.

Population size: 617, Confidence level: 1.96, Error proportion: 0.05, p: Probability: 0.5.

Study Population

The study population included all HCWs in the four main hospitals including physician, nurses, laboratory technician, and others (physiotherapists, nutritionists, pharmacists, dentist and radiographer.

Sample Procedures and Sampling Technique

Simple random sampling was used to select the study participants. HCWs in all departments were invited to participate in the study. A permission was sought from the hospital administration prior to carrying out questionnaire distribution. All participants were given questionnaire to be completed, after obtaining verbal consent from them. A total of 337 questionnaires were distributed and 335 questionnaires were returned as follows: Naser-103 participants, Al-Thawrah-112 participants, Al-Noor-60 participants and Al-Manar Hospitals-60 participants.

Study Questionnaire

This study utilised a self-administered questionnaire to gather data from the respondents. Confidentiality was maintained by avoiding use of names. The survey tool had three sections. Section one had socio-demographic information such as age, gender, occupation, department, and years of experience. Section two was about medical waste management knowledge, such as medical waste risks, training, guidelines in the departments on how to handle medical waste, medical waste separation, waste handling safety, and the availability of facilities to ensure the safe disposal of medical waste. Section three focused on medical waste management practices such as reading medical waste disposal guidance and leaflets, enforcing laws related to medical waste, wearing Personal Protective Equipment (PPE), treating needles and sharp instruments with caution, washing hands and raising awareness in others about the risk of medical waste.

It was assessed using the WHO disposal of medical waste knowledge questionnaire for HCWs [2]. Some modifications (wordings were changed) were made to suit the respondents local language and culture.

The tool included three responses - yes, no and don't know. Correct responses were counted and recorded for each respondent as the positive response gets the high scores. Higher scores indicate a positive practice and better knowledge of disposal of medical waste among HCWs.

The questionnaire was in Arabic language and it took about 15 minutes to be filled. Face validity was determined through pilot study with the help of the questionnaire on 30 HCWs. The reliability was assessed using Cronbach's alpha. The Cronbach's e alpha value of the questionnaire was 0.856.

STATISTICAL ANALYSIS

Data analysis was performed using SPSS version 25.0. Frequency count, percentage, standard deviation and mean values were used to analyse the knowledge and practice of disposal of medical waste. Tests that were used to analyse data were Mann-Whitney test, Pearson's Chi-square test, and Spearman test. Significance was set at <0.05 level.

RESULTS

A total of 337 questionnaires were distributed and 335 returned, giving a response rate of 99%. The age of participants ranged from 20 to 56 years with mean age of 31.36±8.121years. The mean age of female participants was 28.51±6.327 years and that of male participants was 33.08±8.599 years. Most of the participants had a diploma (47.8%), their occupation was nursing (41.2%), laboratory technician (20.3%), physician (19.4%), midwives (5.1%) and they had less than five years or work experience (50.7%) [Table/Fig-1].

Variable	N (%)
Gender	
Male	204 (60.9)
Female	131 (39.1)
Hospital name	
Al-Thawrah	114 (34)
Al-Noor	59 (17.6)
Al-Manar	59 (17.6)
Naser	103 (30.8)
Education	
Diploma	160 (47.8)
Bachelor	150 (44.8)
Master	19 (5.6)
PhD	6 (1.8)
Occupation	
Physician	65 (19.4)
Nurse	138 (41.2)
Lab Technician	68 (20.3)
Midwife	17 (5.1)
Others	47 (14)
Years of experience	
<5 years	170 (50.7)
6-10 years	78 (23.2)
11-15 years	34 (10.1)
>15 years	53 (15.8)
Department	
Internal Medical	40 (12.1)
Surgical	42 (12.8)
Intensive care unit	44 (13.3)
Operation	25 (7.6)
Others	179 (54.2)

[Table/Fig-1]: Socio-demographic characteristics of healthcare workers. Some data were not filled in by the participants

About 68.4% of the participants mentioned that there are laws on how to deal with medical waste in their hospitals. Around 18.3% of study did not distinguish hazardous and non-hazardous medical waste. About 29.8% of the study participants joined immunisation campaigns to prevent any possible future infection of medical waste [Table/Fig-2].

Item No.	Knowledge statement	Yes n (%)	No n (%)	Don't know n (%)
1	Do you have an idea of the risks of medical waste?	310 (92.5)	21 (6.3)	4 (1.2)
2	Do you know who is responsible for handling medical waste in hospitals?	235 (70.6)	55 (16.5)	43 (12.9)
3	Are there any laws or systems regarding to how to deal with medical waste in hospitals?	229 (68.4)	61 (18.2)	45 (13.4)
4	Are training courses offered to educate workers about the danger of waste and how to dispose it?	195 (58.9)	91 (27.5)	45 (13.6)
5	Is there internal control in hospitals to follow-up and apply the laws and systems of handling medical waste?	194 (58.4)	83 (25)	55 (16.6)
6	Are there guidelines in the departments related to how to handle medical waste?	177 (53.3)	127 (38.3)	28 (8.4)
7	Can you differentiate between the waste types?	295 (88.3)	32 (9.6)	7 (2.1)
8	Is hazardous medical waste separated from non-hazardous?	238 (71.5)	61 (18.3)	34 (10.2)
9	Is the place of storage waste within the environmental specifications?	166 (49.8)	93 (27.9)	74 (22.2)

10	Do you know the ways of treating medical waste?	236 (70.9)	57 (17.1)	40 (12.0)
11	Do you know that the final disposal of medical waste varies according to its type?	284 (86.3)	21 (6.4)	24 (7.3)
12	Are there a facilities to ensure the safe disposal of medical waste?	134 (41.0)	115 (35.2)	78 (23.9)
13	Do you report the accidents of handling medical waste?	126 (38.1)	107 (32.3)	98 (29.6)
14	Are there any immunisation campaigns for workers to prevent any infection of medical waste?	99 (29.8)	179 (53.9)	54 (16.3)

[Table/Fig-2]: Knowledge of healthcare workers at the main hospitals in Ibb, Yemen.
Some data were not filled in by the participants

About 58.9% of the participants mentioned that they accepted the offer to attend training on medical waste management [Table/Fig-2]. This study found that only 53.3% of HCWs always wore protective clothes when dealing with medical waste. Furthermore, 85.9% of the study participants deal carefully with needles and sharp tools after use. In addition, 76.7% of the participants always wash hands at the end of their work with a disinfectant or sterilise [Table/Fig-3].

No.	Practice statement	Always N (%)	Frequently N (%)	Sometimes N (%)	Never N (%)
1	I care about reading the guidance and posters regarding to the medical waste disposal.	140 (41.8)	109 (32.5)	83 (24.8)	3 (0.9)
2	I care about applying the instructions and laws which related to medical waste.	183 (55.0)	106 (31.8)	43 (12.9)	1 (0.3)
3	I care about wearing special and protective clothes from the medical waste risks.	177 (53.3)	89 (26.8)	53 (16.0)	13 (3.9)
4	I care about separating waste in their specific boxes.	191 (57.4)	85 (25.5)	47 (14.1)	10 (3.0)
5	I deal carefully with needles and sharp tools after use.	287 (85.9)	34 (10.2)	12 (3.6)	1 (0.3)
6	I wash my hands at the end of the work with a disinfectant or sterilise to protect myself from the risks of medical waste.	257 (76.7)	60 (17.9)	18 (5.4)	0
7	I participate in raising awareness of others through alerting about the danger of medical waste.	158 (47.2)	89 (26.6)	76 (22.7)	12 (3.6)

[Table/Fig-3]: Practice of healthcare workers.
Some data were not filled in by the participants

The mean knowledge of the participants was good (1.39±0.45), as most of the answers in the knowledge domain were high. This indicates that HCWs have good knowledge on medical waste disposal. In the practice domain, most of the answers were also positive and the overall mean practice was (3.41±0.45). This indicates that HCWs have good practice on medical waste disposal. Mann-Whitney and Kruskal Wallis tests were applied to compare scores of each domain with socio-demographic factors. For knowledge, participants with diploma qualification showed significant higher mean knowledge score than others (p=0.030). Nurse showed statistically significant higher mean knowledge and practice scores than others (p=0.001, p=0.002; respectively).

Participants from Naser hospital has a higher mean knowledge score than participants from other hospitals (p=0.001). No statistically significant difference in scores was observed among other socio-demographic factors [Table/Fig-4].

A moderate positive correlation was found between knowledge and practice (r=0.505 and p=0.001). There was a statistically

Variables	Mean knowledge scores	p-value	Mean practice scores	p-value
Gender				
Male	173.62	0.184	170.72	0.519
Female	159.25		163.76	
Education				
Diploma	180.66	0.030*	174.45	0.640
Bachelor	161.57		163.28	
Master	116.32		150.76	
PhD	154.75		168.50	
Occupation				
Physician	150.42	0.001*	176.71	0.002*
Nurse	193.75		187.61	
Lab tech.	135.10		141.88	
Midwife	172.97		173.32	
Others	162.53		134.24	
Experience period				
<5 years	160.16	0.233	157.27	0.083
6-10 years	165.38		167.96	
11-15 years	191.37		180.54	
>15 years	182.01		194.42	
Department				
Internal medicine	151.83	0.552	176.44	0.840
Surgery	156.36		166.23	
Intensive care unit	177.10		175.09	
Operation	186.04		159.42	
Others	164.98		161.38	
Hospital name				
Al-Thawrah	145.69	0.001*	152.50	0.124
Al-Noor	143.72		167.54	
Al-Manar	171.13		170.90	
Naser	204.81		183.75	

[Table/Fig-4]: Mean score with respect to socio-demographics of healthcare workers.
*p-value <0.05 is statistically significant; Pearson's Chi-square test

significant association between different hospitals and knowledge (p=0.013). Participants from Naser hospital had higher mean scores (26.3%) compared to others. There was a significant association between occupation and knowledge (p=0.014). Nurses scored the highest mean (33.7%) compared to other HCWs. Age and years of experience did not significantly influence the knowledge and practice of the HCWs [Table/Fig-5].

Variables	Knowledge		χ^2	p-value
	Poor	Good		
Gender				
Male	48 (14.3%)	156 (46.6%)	0.435	0.510
Female	35 (10.4%)	96 (28.7%)		
Age				
<30	40 (12%)	121 (33.7%)	1.246	0.870
≥30	42 (12.7%)	137 (41.5%)		

Education				
Diploma	35 (10.4%)	125 (37.3%)	1.509	0.680
Bachelor	41 (12.2%)	109 (32.5 %)		
Master	5 (1.5%)	14 (4.2%)		
Physician	2 (0.6%)	4 (1.2%)		
Department				
Internal medicine	12 (3.6%)	28 (8.5%)	1.246	0.870
Surgery	11 (3.3%)	31 (9.4%)		
Intensive care unit	12 (3.6%)	32 (9.7%)		
Operation	5 (1.5%)	20 (6.1%)		
Others	42 (12.7%)	137 (41.5%)		
Occupation				
Doctor	18 (5.4%)	47 (14.0%)	6.791	0.014*
Nurse	25 (7.5%)	113 (33.7%)		
Lab Technician	23 (6.9%)	45 (13.4%)		
Midwife	4 (1.2%)	13 (3.9%)		
Others	13 (3.9%)	34 (10.1%)		
Hospital name				
Al-Thawrah	35 (10.4%)	79 (23.6%)	10.785	0.013*
Al-Noor	20 (6%)	39 (11.6%)		
Al-Manar	13 (3.9%)	46 (13.7%)		
Naser	15 (4.5%)	88 (26.3%)		
Experience (Years)				
<5	47 (14%)	123 (36.7%)	5.32	0.149
6-10	22 (6.6%)	56 (16.7%)		
11-15	4 (1.2%)	30 (9%)		
>15	10 (3%)	43 (12.8%)		

[Table/Fig-5]: Social-demographic characteristics and knowledge of healthcare workers.
*p-value <0.05 is statistically significant; Pearson's Chi-square test

DISCUSSION

Healthcare activities restore health and save lives, however, it generates many hazardous medical wastes that affects human health. Disposal of medical wastes have become a global emerging issue. Therefore, the objective of this study was to determine knowledge and practice of HCWs at the main hospitals in Ibb city, Yemen.

The findings of this study reported that more number of nurses participated in the study. This study was similar to a previous one conducted in South Africa, in which more nurses than physicians participated in such studies [8]. This demonstrated that nurses are still eager to volunteer in such studies.

Knowledge

This study indicates that respondents had a good knowledge. The present study contradicted another study from Yemen, where knowledge on medical waste among HCWs in private and public hospitals was insufficient (44%) [7]. A study from India found that the medical practitioners did not have sufficient knowledge about how to properly dispose of medical waste [9]. This may due to the differences in the studies location, participants and design.

Furthermore, in this study, 68.4% of the participants mentioned that there are laws on how to deal with medical waste in their hospitals. In developed countries, where definite rules and regulations exist at all levels of the healthcare system, it is vital to plan standard operating procedures for medical waste management in hospitals. Furthermore, proper monitoring and enforcement strategy are crucial for proper medical waste management [10]. Yemen is yet to adopt a practical guide in managing and disposing medical waste. The current practice is co-disposal with non-hazardous wastes at landfill sites [11]. In Yemen, the most popular method of disposing of medical waste is to bury them in open dumps [11]. These practices are also carried out in some Arabic nations like Egypt [12]. Microwave plasma sterilization and incineration is the method used for disposal of medical waste in United States of America (USA) [13]. Total 3% of the study participants never separated medical waste. A study from Iran reported that hazardous waste was mixed with non-hazardous waste generated in the hospitals, then transferred to the final disposal site [14]. Another study reported that 67% of the HCWs did not segregate waste at source [15]. Several studies reported poor medical waste segregation practice among HCWs [16,17]. An Indian study showed that sometimes wastes were mixed with non-hazardous byproducts, making the whole operation ineffective [18]. Therefore, there is an urgent need for medical waste separation and training about medical waste management for all HCWs in Yemen. According to the general standard roles, healthcare waste is expected to be in coloured containers. These issues may be due to the lack of awareness and insufficiency funds. Only 38.1% of the participants reported that incidents of mal-handling medical waste were reported. The reported incidence of sharps injuries in literature ranges widely among HCWs per year; therefore, the underestimation of accidents could be a widespread concern [7,11]. The under reporting may be due to time constraints and fear of punishment from their superior.

About 29.8% of the study participants are aware of immunisation campaigns to prevent any possible future infection of medical waste. This percentage is discouraging and more immunisation campaigns should be held in the whole country to promote immunisation and also to encourage more HCWs to be vaccinated against Hepatits B Virus (HBV) and other vaccinations. Furthermore, 85.9% of the study participants always dealt carefully with needles and sharp tools after use. In addition, 76.7% of the participants always washed hands at the end of the work. The high percentage of washing hand and handling needles and sharp tools carefully indicated the high knowledge among the participants. However, more training and education need to be provided at all healthcare facilities nationwide to increase awareness about the risk of medical waste. No previous study conducted in Yemen investigated the immunisation among HCWs. In Yemen there is no regulation regarding immunising the HCWs before starting the clinical practice like taking HBV vaccination. Therefore, there is an urgent need to vaccinate the healthcare workers using HBV vaccine and COVID-19 vaccine.

PPE such as face masks, gloves, goggles, gowns, and aprons are necessary for individual protection from exposure to pathogens like COVID-19 and contaminants like medical waste. This study reported that only 53.3% of HCWs wear protective clothes when dealing with medical waste. A previous study from Yemen, PPE was used by 20% of HCWs in public hospitals and 33.3% of HCWs in private hospitals [7]. An Egyptian study found that more than 70% of nurses wear PPE [19].

This may be attributed to the general situation in Yemen, which is facing the worst humanitarian crisis in the recent history. In addition, to the war and conflict that has been ongoing since 2011. Total 58.9% of the participants said if a course is offered about medical waste management they would join.

A lack of medical waste management training among HCWs staff has been identified in several studies in India, Pakistan and Bangladesh [20-23]. A similar finding from Ethiopia reported that 53.1% of HCWs didn't take any training on medical waste management [24].

Gender: In this study, gender was not found to be associated with knowledge and practices. A study from India also showed that there was no statistical relationship between knowledge and gender [25].

Age: The result of this study showed that there was no significant association between age and knowledge. Previous research backs up present study findings that there was no significant association between age and knowledge [26,27]. However, one study found a substantial link between age and knowledge [28]. The differences in

these studies may due to the study design, type of population and sample size.

Occupation: This study found that nurses are more knowledgeable about medical waste management than others (p=0.001). This was similar to previous studies indicated that nurses had better knowledge than other healthcare workers [29-35]. This was in contrast with the study that found no significant association between professional category and practice [25]. Another study done in Ethiopia showed medical doctors had better risk perception than other health workers [24]. This may be explained by the fact that the nursing staff gain experience by working on a regular basis and handling medical waste regardless of their qualifications, years of experience, or place of employment.

Education and knowledge: In this study, knowledge of HCWs regarding medical waste management was statistically significant in relation to their education. However, practice of HCWs was not statistically significant in relation to their education. On the contrary, a study from Iran showed that the practice of health-care regarding medical waste management was statistically significant in relation to the level of education [35]. As a result, education plays an important role in raising awareness among healthcare workers.

Type of hospital: Type of hospital showed a statistically significant related to knowledge (p=0.001) but not significant for practice (p=0.124). The results show that participants from Naser hospital had a higher level of knowledge than others hospitals. This may due to the presence of the international organisation called Doctors without borders or Medicines Sans Frontiers (MSF) in this hospital.

Years of experiences: The results of this study showed that years of experience did not have association with knowledge of medical waste management. This was in contrast with previous studies [19,25,36]. These differences may due to the differences settings and priorities in healthcare systems.

Correlation: The results of the study found a moderate positive relationship between knowledge and practice of medical waste of medical waste disposal at selected hospitals in Ibb city, Yemen. Several previous studies found a correlation between participants' level of knowledge and their practices [37-39]. In addition, another study showed that increase in the knowledge will increase the good practices [40]. Moderate correlations recorded in this study can be attributed to the fairly consistent high score levels of knowledge and practices of the respondents.

Limitation(s)

This study was conducted only in one Yemen city and thus it may not represent the entire country. In addition, the study was conducted during Yemen's conflict and the war, during which half of the country's healthcare facilities were destroyed, local specialists and experts fled the country and everyone's main concern was to survive.

CONCLUSION(S)

Occupation, type of hospital and education level significantly influenced the knowledge of Yemeni nurses. Contentious education should be focused on medical waste management among healthcare workers nationally. There is an immediate need for ongoing training about medical waste management for hospital staff at Ibb and other states in Yemen. Training should be carried out by the Ministry of Health, Yemen and universities in different forms such as seminars, workshops, and conferences. Its important to organise medical campaign in order to build awareness and urgency of safe disposal of medical waste and medical waste management among general population.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jan 15, 2021
- Manual Googling: Mar 15, 2021
- iThenticate Software: May 31, 2021 (15%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jan 14, 2021**
Date of Peer Review: **Feb 20, 2021**
Date of Acceptance: **Apr 03, 2021**
Date of Publishing: **Jun 01, 2021**