Original Research Article

Medical Waste Management among Hospital Health Professionals in Beirut

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ABSTRACT

Background: Improper handling and disposal of medical wastes directly expose health workers to infectious diseases. The purpose of this research was to assess knowledge, perception, and practices of healthcare workers associated with medical waste management in six hospitals in Beirut, Lebanon.

Methodology: This is an observational cross-sectional study. Data was collected from 395 participants via a stratified random sampling method using a questionnaire providing information on the knowledge, perception, and practices regarding the waste management among the healthcare workers at the hospitals studied. Descriptive statistics analysis was used to assess the significance of the results.

Results: Findings revealed that there were significant differences in knowledge, perception, and practices of waste management among the five categories of health workers. Among the respondents approved (N=388); 57.7% have good knowledge, 61.3% have good perception, and 55.2% have good practices scores. Healthcare professionals have the highest knowledge (54.9%, p<0.001), perception (54.6%, p<0.001), and practices scores (55.1%, p<0.001). The clinical waste collectors and cleaners have the lowest knowledge (5.8%, p<0.001), perception (2.1%, p<0.001), and practices scores (13.6%, p<0.001).

Conclusion: The results reveal that hospital waste management is very poor among clinical waste collectors and cleaners. As a recommendation to improve this situation, all categories of healthcare workers in Lebanon should have ongoing training on medical waste management

Keywords: Medical Waste Management, Healthcare waste, Healthcare worker, waste handlers, Knowledge, attitudes, practices.

INTRODUCTION

Healthcare wastes (HCW) generated by healthcare facilities are classified into general wastes and hazardous wastes:

- General wastes are generated by the following departments: secretariat, restoration, maintenance and material wrapping. They don't present a particular risk and can be eliminated by the same network as the household wastes.

- Hazardous wastes are the pharmaceutical, genotoxic, radioactive, infectious, and chemical wastes [1].

There are two main exposed groups: Inside the hospital (Healthcare workers, technical and logistics staff, visitors, and patients), and outside the hospital (drivers in charge of transporting waste, operators in the treatment/elimination, and the general population).

Improper handling and disposal of waste generated from healthcare facilities directly expose health workers to infectious diseases

such as AIDS and hepatitis [2]. The WHO estimates that each year there are about 8 to 16 million new cases of Hepatitis B virus (HBV), 2.3–4.7 million cases of Hepatitis C virus (HCV) and 80,000–160,000 cases of Human Immunodeficiency Virus (HIV) due to unsafe injections disposal and mostly due to very poor waste management systems [3]. Inadequate management of The HCW impose different consequences among the groups of employees. In fact, waste handlers and the hospital cleaning staff are highly exposed as a result of their direct contact with HCW throughout segregation, collection, transport, storage, and final disposal processes. In addition, the HCW present adverse outcome to the environment. Indeed, many infectious agents can be spread via environmental surfaces and even via air, responsible of poisoning the underground water tables. Furthermore, the municipal waste must be segregated from HCW since it tends to be collected accompanied by the rest of the waste stream and disposed of in populous waste landfills or inappropriate treatment locations [3].

Consequently, a remarkable increase in public concern for hospital waste disposal took place in the last decade [4]. Thus, the healthcare facilities are responsible of supervising public health affairs such as medical waste (MW) with the help of a committed waste management team. Furthermore, controlling HCW is an essential part of a national care system. Yet, financing of HCW management remains very insufficient [3].

As reported by hospital services, medical waste contains 10–25 % biohazardous material and 75–90 % non-hazardous waste [1].

In order to limit the HCW mismanagement consequences, healthcare workers directly exposed to these hazardous wastes must have the appropriate knowledge of HCW high risk on health, and practice safety measures which also are a base for waste safe disposal [2].

As stated by the guidelines, healthcare facilities should implement six uninterrupted steps in the management of healthcare wastes [8, 9, 11-14]. The process incorporates segregation, collection, storage, transportation, treatment, and disposal [10, 15, 16]. Segregation at the source is essential. It is the ideal way of decreasing the amount of hazardous waste and isolate the infectious from the chemical, toxic, and radioactive waste. Sorting involves a coherent recognition of the waste types and their separation in containers, or plastic bags. Healthcare workers with direct contact with waste have to be secured from encountered risks. Precautionary measures of contact protection have to be taken correspondingly [5]. The protective contact measures, vaccination, and precautionary immunization post exposure according to procedures must be established. However, health workers in many developing countries present a low level of knowledge and practices of healthcare waste management (HCWM). Staff education is essential to highlight the task of each one and to make them alert about waste management modalities. The training has to be done by the person in charge of healthcare, the trainer, or by an outsourced agency [5]. Waste Management Officer (WMO) is in charge of the daily operation and monitoring of the waste management system. The WMO should cooperate with the Infection Control Officer and the head of each department in order to become familiar with the correct procedures for handling and disposing of hazardous waste. All hospital personnel, including senior medical doctors, should be convinced of the need for a comprehensive health-care waste management policy and the related training, and of its value for the health and safety of all [8].

As for the treatment and disposal, incineration and open burning methods were designed to manage hazardous wastes separately from non-hazardous wastes [9, 15, 17 – 22]. Medical institutions use burial pit [9,

[18, 23], while others use open dumping [9, 19, 22, 24].

In Lebanon the expansion of healthcare facilities increased medical wastes and as a consequence the possibility of spreading the disease through inadequate handling and disposal practices.

Hence, this present survey aims to evaluate the knowledge, perception, and practices associated with medical waste in six hospitals in Beirut, Lebanon.

MATERIALS & METHODS

Quantitative descriptive research method has been chosen, which is frequently depicted as presenting a static image of social reality with an emphasis on relationships between variables. In this cross-sectional study, the sample size for qualitative variable was calculated according to a formula exposed by Pourhouseingholi et al (2013) [25].

Questionnaire design

An established questionnaire of 39 items was used including five sections. All questions were a closed-end type:

- The first section gathers basic information in order to analyze the demographic variables.
- The second section focuses on knowledge of health workers regarding HCWM.
- The third section evaluates the perception of health workers regarding HCWM.
- The fourth section evaluates the practice of health workers regarding HCWM.
- The fifth section examines the category of waste which included general waste, infectious waste, pathological waste, and sharps.

We used a mean score for the level of knowledge, the level of perception, and the level of practice of health worker as a cut of point. A score calculated for each variable greater than or equal to the mean of the corresponding variable were categorized as having good knowledge, perception, and practice. The level of knowledge was computed from 13 knowledge related questions and the mean score (10.58) was generated for each respondent. The level of perception was assessed with 7 questions and the mean score (6.42) was generated for each respondent. The level of practice was computed with 9 questions and the mean score (6.32) was generated for each respondent. The distribution was normal during normality check-up. We translated this questionnaire into Arabic and French. Trained interviewers (two medical residents and two paramedical employees) administered the questionnaire to available consenting paramedical and medical staff. Interviews with participated workers were performed, as most of the targeted workers were illiterate or had limited educational level.

Data sources

Between January and June 2023, 395 respondents in six hospitals were randomly selected using stratified, simple random and convenience sampling methods. This approach ensured that the various categories of hospitals operating in Greater Beirut (GB) were included in the study and coding of the hospitals was done to ensure confidentiality. The hospitals' managers selected were asked to provide the total number of workers in each stratum. In fact, the strata selected to our study were: Medical student, paramedical professional/student, healthcare professional (MD, nursing, midwife, and pharmacist), and employee (management team, admission, secretary, accountant, cafeteria, staff that cleans the hospital and collects waste).

The following steps were performed then: (1) The size of the smallest stratum is determined from which the number of people required to achieve the desired error level (5%) and level of confidence (95%) was calculated. (2) The number of people in each of the other strata to achieve the same ratio was deducted.

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS version 24) was used for the analysis of the data. Chi-square statistical test of significance was used to determine the level of significance of the association between variables at a 95% confidence level. The level of significance was set at $p \leq 0.05$.

Ethical considerations

Approval of ethical committees of the selected hospitals was obtained. In addition, the WHO's Research Ethics Committee [8] were followed in our observational epidemiological research. We ensured that research respondents were not subjected to harm in any whatsoever. The quality of expression, the non-offensive and nondiscriminatory language, were applied. The participants were asked whether they took any offence on the questionnaires content and if their dignity was respected. Therefore, the questionnaire has an introductory section explaining the purpose of the research, including a statement of related interests, and an assurance of adequate levels of confidentiality. Finally, the respondents were assured that the study was made neither to assess their performance nor to blame anyone for weakness.

RESULT

Sample size

The minimum sample size needed for our study is 383 according to the formula:

Sample size= (Z1-α/2) x 2f (1-f)/d2 where Z1-α/2: is the standard normal variant at 5% type I error (p <0.05), it is 1,96; f: is the expected proportion in population on previous studies; and d: is the absolute error or precision [25].

Socio-demographic Characteristics

Out of a total of 395 questionnaires, 7 were excluded for incomplete filling of information, lack of data, and absent of the consent form signature. Four private hospitals in Greater Beirut participated to the study with 82% of the total number of respondents, the rest was filled by participants from two public hospitals in the capital. As shown in table 1, among the valid 388 respondents, 45.1% were male and 54.9% female. 68.6% of respondents were in the age group of higher or equal to 25 years old and the majority were single (58%). Lebanese participants were 90.7 % while 9.3% were of the Bangladesh nationality. The lowest percentage of the respondents came from paramedical employee/students (6.7%), the employee category 23.9% and the healthcare professionals 47.4%. The subjects were of intermediate education (5.7%), secondary (24.2%), university diploma (51.5%) and master/doctor degree (18.6%). Almost half of the respondents were in the range of the duration of employment between 2 and 9 years in service.

Table 1. Socio-demographic data

Variable	Type	Frequency	Percentage
Public/Private	Public	70	18
	Private	318	82
Age (years)	≤ 19	11	2.8
	20-24	111	28.6
	≥ 25	266	68.6
Gender	Male	175	45.1
	Female	213	54.9
Marital Status	Single	225	58
	Married	163	42
Nationality	Lebanese	352	90.7
	Other	36	9.3
Educational Status	Intermediate education	22	5.7
	Secondary education	94	24.2
	University	200	51.5
	Master, MD	72	18.6
Profession of respondents	Medical student	49	12.6
	Paramedical student	26	6.7

	Healthcare professional	184	47.4
	Employee	93	23.9
	The staff that cleans the hospital and collects waste	36	9.3
Duration of Employment	< 2 years	91	23.5
	2≤ <4 years	102	26.3
	4≤ <9years	86	22.2
	9≤ <14 years	61	15.7
	14≤ <19 years	28	7.2
	≥ 19	20	5.2

Knowledge of participants

46.9% of participants were aware of the existence of five types of medical wastes. 94.8% of studied subjects were aware also that the infectious waste should be disposed of in a safety box or yellow plastic bags. It was found that 82.2% of participants knew that three quarter full or less is the right quantity of wastes that should be put in the container. 61.1% of participants knew the existence of rules and regulations about Medical Waste Management in Lebanon. When targeted workers were asked about how should infectious waste be disposed, 37.4% responded burying and 62.6 % responded incinerator/burning. 97.7% knew the necessity of color-coding segregation of healthcare wastes in hospitals. It was found that 97.4% knew that injuries need to be announced. 93% of the participants knew about the requirement of standard storage rooms for healthcare wastes. The results showed that 89.2% of the subjects answered that waste management needs an annual plan. The level of knowledge was computed from 13 knowledge related questions and the score was generated for each respondent. The mean score was used as a cut of point to say good or poor knowledge. Out of the 388 participants, 57.7% had good knowledge on health care waste management. The results are shown in the tables 2a and 2b.

Table 2a. Knowledge variable

Variable		Frequency	Percent
Knowledge:	Poor	164	42.3
	Good	224	57.7
	Total	388	100

Table 2b. Knowledge of health workers regarding HCWM

Variable	Type	Frequency	Percentage
Number of medical wastes	< 5	206	53.1
	5	182	46.9
Place of disposition of infectious waste	Strong black disposable plastic bags	20	5.2
	Safety box or yellow plastic bags	368	94.8
Quantity of wastes put in the container	Full > 75%	69	17.8
	≤ 75%	319	82.2
Presence of rules and regulations about MW management in Lebanon.	Yes	237	61.1
	No	151	38.9
Infectious waste to be disposed	Bury	145	37.4
	Incinerator/burning	243	62.6
Color-coding segregation importance	Yes	379	97.7
	No	9	2.3
Mandatory announcement of Injuries	Yes	378	97.4
	No	10	2.6
Standard storage rooms importance	Yes	361	93
	No	27	7
Annual plan required	Yes	346	89.2
	No	42	10.8

Category of wastes

95.6% of the participants categorized promptly paper, food, plastics, and bottles as general waste. Soiled cotton wool, swab, and gloves were also classified by 80.4 % of the respondents as infectious wastes. 77.8% of the respondents classified body parts, body fluids, and foetuses as pathological wastes. 85.1% of the respondents categorized that Needles, Scalpels, and

Syringes belong to the Sharps category. The results are shown in table 3.

Table 3: Category of Waste

Variable	Type	Frequency	Percentage
Paper, Food, Plastic, Bottles	Infectious waste	5	1.3
	General Waste	371	95.6
	Pathological Waste	11	2.8
	Radioactive waste	0	
	Sharps	0	
	Pharmaceutical waste	1	0.3
Soiled cotton wool, Swab, Gloves	Infectious waste	312	80.4
	General Waste	28	7.2
	Pathological Waste	10	2.6
	Radioactive waste	1	0.3
	Sharps	2	0.5
	Pharmaceutical waste	35	9
Body parts, Body fluids, Fetuses	Infectious waste	78	20.1
	General Waste	3	0.8
	Pathological Waste	302	77.8
	Radioactive waste	0	
	Sharps	4	1
	Pharmaceutical waste	1	0.3
Needles, Scalpels, Syringes	Infectious waste	35	9
	General Waste	4	1
	Pathological Waste	9	2.3
	Radioactive waste	4	1
	Sharps	330	85.1
	Pharmaceutical waste	6	1.5

Perception of participants

For 98.2 % of the respondents, healthcare waste management is important. 90.5% of participants approved the importance of follow-up by the responsible, and 95.9% mentioned that on-job training is essential. 86.1% of the participants were aware of the risks of Medical Waste to the health and environment. 94.6% of participants agreed that daily waste collection and transportation is necessary, and 91.8% approved that Medical Waste Management is a teamwork. 85.8% of the studied subjects knew that general health-care waste should be disposed of in black bags. The perception of the health workers who have participated in this study was assessed with 7 questions and score was generated for each respondent. The mean score was used as a cut of point to say good or poor perception. Out of the 388 participants, (61.3 %) had good perception and the rest (38.7 %) had poor perception towards HCWM. The results are shown in the tables 4.a and 4.b.

Table 4a. Perception variable

Variable	Frequency	Percent
Perception Poor	150	38.7
Good	238	61.3
Total	388	100

Table 4b. Perception of health workers regarding HCWM

Variable	Type	Frequency	Percentage
Importance of health care management	Yes	381	98.2
	No	7	1.8
Importance of the responsible body for follow up	Yes	351	90.5
	No	37	9.5
Importance of the on-job training	Yes	372	95.9
	No	16	4.1
Awareness of the risks of Medical Waste to the health and environment	Yes	334	86.1
	No	54	13.9
Necessity of daily waste collection and transportation	Yes	367	94.6
	No	21	5.4
Is Medical Waste Management a team work?	Yes	356	91.8
	No	32	8.2
Color codes for disposal of general waste.	Red	9	2.3
	Yellow	40	10.3
	Blue	6	1.5
	Black	333	85.8

Practice of participants

28.4 % of the participants recap the needles, and 64.2 % always use gloves. 89.9% mentioned that they do dispose of general and clinical wastes separately. 78.6% mentioned that they color-code their medical waste for disposal. Only 24 % of the respondents knew that pathological waste should be disposed of in grey bags. 83 % of the studied subjects knew that Infectious waste should be disposed of in yellow bags. 60.3 % mentioned that they have procedures for collection/handling of wastes. 94.8% agreed that Safety boxes are the container for sharps disposal, not a Nylon bag. The level of practice was first computed from 9 practice-related questions and score was generated for each respondent. The mean was calculated and used as a cut of point. Those whose score is greater than or equal to the mean were categorized as having good practice and those with a score of less than the mean was categorized as having poor practice. Accordingly, (55.2 %) of the respondents had good practice on healthcare waste management. The results are shown in the tables 5.a and 5.b.

Table 5a. Practice variable

Variable	Frequency	Percent
Practice: Poor	174	44.8
Good	214	55.2
Total	388	100

Table 5.b. Practice of health workers regarding HCWM

Variable	Type	Frequency	Percentage
Practice of recapping needles?	Yes	110	28.4
	No	278	71.6
Frequency of using gloves	Sometimes	139	35.8
	Always	249	64.2
Usage of personal protective equipment?	Yes	269	69.3
	No	119	30.7
Disposal of general and clinical wastes separately	Yes	349	89.9
	No	39	10.1
Color-coding of the medical waste for disposal	Yes	305	78.6
	No	28	7.2
	I don't know	55	14.2
Color-coding for Pathological waste	Red	25	6.4
	Yellow	113	29.1
	Grey	93	24.0
	Yellow and radioactive symbol	28	7.2
	Black	9	2.3
	I don't know	120	30.9
Color coding for Infectious waste	Red	11	2.8
	Yellow	322	83
	Grey	0	
	Yellow and radioactive symbol	27	7
	Black	4	1
	I don't know	24	6.2
Do you have procedures for collection/handling of wastes?	Yes	234	60.3
	No	47	12.1
	I don't know	107	27.6
Type of container for sharps disposal	Nylon bag	20	5.2
	Safety boxes	368	94.8

Socio-demographic variables and knowledge of HCWM.

According to the results in table 6, significant differences were found between the socio-demographic variables (nationality, profession of respondents, and educational status) and the knowledge of healthcare towards waste management (p ≤ 0.05). However, no significant statistical difference was found for the variables (Public/Private hospital, Age, Gender, current marital status, and duration of employment.

Table 6. Differences in knowledge of HCWM and the socio-demographic variables

Variables		Frequency	Practice		*P*
			Good	Poor	
Public hospital		18	17	19.5	
Private hospital		82	83	80.5	0.519
Age of respondents (years).	≤ 19	2.8	1.8	4.3	
	20-24	28.6	30.8	25.6	0.217
	≥ 25	68.6	67.4	70.1	
Gender:	Male	45.1	46	43.9	
	Female	54.9	54	56.1	0.684
Current marital status:	Single	58	58	57.9	
	Married	42	42	42.1	0.983
Nationality:	Lebanese	90.7	94.2	86	
	Other	9.3	5.8	14	0.006
Educational status:	Intermediate education	5.7	3.6	8.5	
	Secondary education	24.2	21.4	28	
	University	51.5	54.5	47.6	0.050
	Master, Doctor	18.6	20.5	15.9	
Profession of respondents:	Medical Student	12.6	13.8	11	
	Paramedical Student / employee	6.7	8.5	4.3	
	Healthcare professional	47.4	54.9	37.2	< 0.001
	Employee	24	17	33.5	
	The staff that cleans the hospital and collects waste	9.3	5.8	14	
Duration of employment (years).	< 2	23.5	23.7	23.2	
	2-4	26.3	28.6	23.2	
	4-9	22.2	18.8	26.8	
	9-14	15.7	17	14	0.288
	14-19	7.2	8	6.1	
	≥ 19	5.2	4	6.7	

P ≤ 0.05 is considered significant

Socio-demographic variables and perception of HCWM.

No significant statistical difference was found between the variable perception of HCWM and the following socio-demographic variables (Age of respondents, current marital status, and duration of employment). However, a significant statistical difference was found for the type of hospital (Public/Private), gender, nationality, educational status, and profession of respondents (Table 7).

Table 7. Differences in perception of HCWM and the socio-demographic variables

Variables		Frequency	Practice		*P*
			Good	Poor	
Public hospital		18	14.3	24	0.015
Private hospital		82	85.7	76	
Age of respondents (years).	≤19	2.8	2.1	4	0.545
	20-24	28.6	29	28	
	≥ 25	68.6	68.9	68	
Gender:	Male	45.1	40.3	52.7	0.017
	Female	54.9	59.7	47.3	
Current marital status:	Single	58	59.7	55.3	0.40
	Married	42	40.3	44.7	
Nationality:	Lebanese	90.7	97.9	79.3	< 0.001
	Other	9.3	2.1	20.3	
Educational status:	Intermediate education	5.7	2.1	11.3	< 0.001
	Secondary education	24.2	19.3	32	
	University	51.5	60.1	38	
	Master, Doctor	18.6	18.5	18.7	
Profession of respondents:	Medical Student	12.6	11.3	14.7	< 0.001
	Paramedical Student/employee	6.7	7.1	6	
	Healthcare professional	47.4	54.6	36	
	Employee	24	24.8	22.7	
	The staff that cleans the hospital and collects waste	9.3	2.1	20.7	
Duration of employment (years):	< 2	23.5	25.2	20.7	0.093
	2-4	26.3	24.8	28.7	
	4-9	22.2	18.9	27.3	
	9-14	15.7	15.5	16	
	14-19	7.2	8.8	4.7	
	≥ 19	5.2	6.7	2.7	

p ≤ 0.05 is considered significant

Socio-demographic variables and practice of HCWM.

Significant statistical difference was found between the variable practice of HCWM and the following socio-demographic variables (age, nationality, educational status, profession of respondents, and duration of employment). However, no significant statistical difference was found for the gender, current marital status of the respondents, and the type of hospital (public/private) (Table 8).

Table 8. Differences in practice of HCWM and the socio-demographic variables

Variables		Frequency	Practice		P
			Good	Poor	
Public hospital		18	19.2	16.7	
Private hospital		82	80.8	83.3	0.525
Age of respondents:	≤ 19	2.8	1.4	4.6	
	20-24	28.6	21.5	37.4	$p < 0.001$
	≥ 25	68.6	77.1	58	
Gender:	Male	45.1	43.9	46.6	
	Female	54.9	53.4	56.1	0.605
Current marital status:	Single	58	53.7	63.2	
	Married	42	46.3	36.8	0.060
Nationality:	Lebanese	90.7	86.4	96	
	Other	9.3	13.6	4	$p < 0.001$
Educational status:	Intermediate education	5.7	8.4	2.3	
	Secondary education	24.2	25.7	22.4	
	University	51.5	52.8	50	0.002
	Master, Doctor	18.6	13.1	25.3	
Profession of respondents:	Medical Student	12.6	5.6	21.3	
	Paramedical Student/employee	6.7	4.7	9.2	
	Healthcare professional	47.4	55.1	37.9	$p < 0.001$
	Employee	24	21	27.6	
	The staff that cleans the hospital and collects waste	9.3	13.6	4	
Duration of employment (years).	< 2	23.5	15.9	32.8	
	2-4	26.3	24.3	28.7	
	4-9	22.2	26.2	17.2	
	9-14	15.7	17.3	13.8	$p < 0.001$
	14-19	7.2	10.7	2.9	
	≥ 19	5.2	5.6	4.6	

p ≤ 0.05 is considered significant

Figure 1. Bar graph of Knowledge, perception, and practice variables
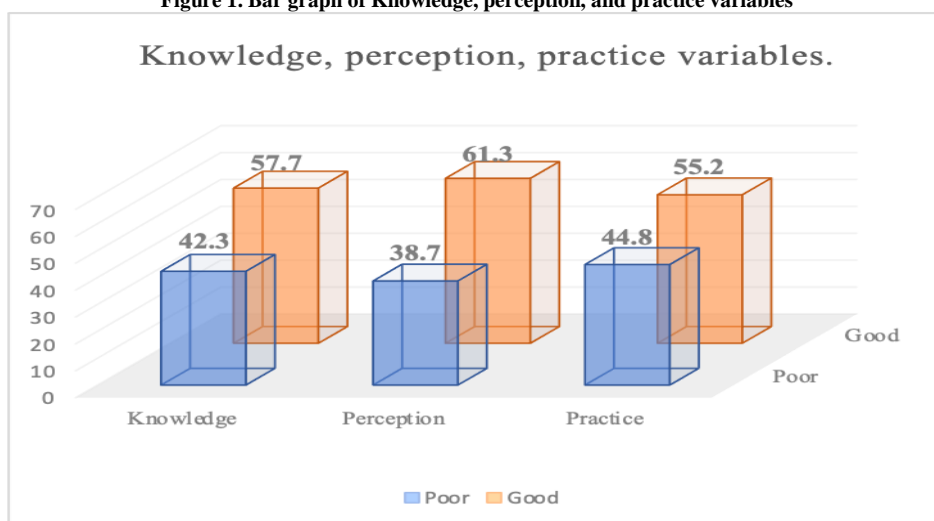
DISCUSSION

The majority of the respondents were female healthcare professionals. The aforementioned is in accordance with the studies of Awodele et al and Mugabi et al [4, 27]. In fact, women become a major force within the medical community. 68.6% of the respondents were over 25 years old. The results are compatible with the work of Doylo et al [6]. Additionally, 51.5% of the respondents have a university degree which is compatible with Doylo et al [6]. In the

present study, 9.3% of the participants is the staff that cleans the hospital and collects the wastes which is agreeable with the findings of Joshua et al [28] that was carried out in some primary health care centers in Zaria-Nigeria. The involvement of the domestic workers is inevitable and logical as they are largely involved in waste collection and transportation.

The majority of the participants had good knowledge of the HCWM. This finding was higher than studies done in Africa (Eastern and North West of Ethiopia, and Tanzania) [6, 17, 29]. These discrepancies are probably due to the quality of the training protocols instituted in each area. The medical personnel in the examined hospitals had sufficient knowledge of the various categories of the wastes produced. Moreover, healthcare professionals were more likely to have good knowledge of HCWM (54.9%) among all the categories studied, while the staff that cleans and collects the wastes has the least knowledge (5.8%). The domestic workers were less knowledgeable about specific aspects of disposal. The latest studies conducted in India and Egypt revealed that knowledge of HCWM was best among doctors and least among the domestic workers and paramedical staff [30, 32]. On the other hand, a cross-sectional study was carried out in the eight surgical departments at Al-Mansoura University Hospital by Mostafa et al showed good knowledge scores of HCWM as follow: 36.8% for the doctors, 32.1% for the domestic workers, and 27.4% for the nurses [33]. Another study conducted in South Africa has showed that nurses have the highest level of knowledge than other category of health professionals [31]. The research conducted in Mangalore, India, in 2012 found the highest rate of knowledge of HCWM was among nurses, followed by doctors [35]. The different results in knowledge between the categories of health workers may be due to the proper and continuous on-job training provided for professionals concerning knowledge of waste management. High rates were reported by most healthcare workers regarding knowledge of the basics of medical waste management and handling aspects, such as the categorization of different types of wastes and the policies on needle-stick injury. The findings are consistent with Asadullah et al [36]. The majority of the respondents categorized well the general from the infectious waste. The results match with Awodele et al [4]. There was satisfactory knowledge of color coding of wastes, it is consistent with the study of Al Khatib et al [37]. These results indicate that satisfactory segregation is conducted properly by using of colored containers or colored liners to effectively separate infectious waste from general/domestic waste. Furthermore, segregation of infectious waste at the source of generation is the key to achieving a sound medical management. The results of our study on the segregation of medical waste concord with the studies of Awodele et al [4] and Asadullah et al [36]. Medical waste segregation decreases the volume of hazardous waste. The majority of the participants use safety boxes for sharp collections and know that the container should only be three-quarters filled before disposal in accordance with the WHO regulation for MWM [38].

Two third of the respondents had good perception of HCWM in our study. There was a statistically significant association within the profession of the respondents and the ability to recognize the color coding for pathological wastes with the greatest association amongst the healthcare professionals compared to the other categories. This finding is consistent with Al Khatib et al [37]. The category of healthcare professionals has the highest perception scores while the domestic staff has the lowest for HWM.

The majority of the participants had good practice of HCWM. Our findings are higher than the studies carried out in Eastern and Northwestern Ethiopia [6, 18]. Moreover, the level of education of healthcare correlated with good practice scores for waste

management [41]. Contrarily, Azuike et al found no statistically significant difference between the educational status of health workers and the practice of HCW [42]. In the present paper, healthcare professionals had the highest good practice scores while the domestic staff had the lowest practice scores for HCW. According to a survey conducted by Sarker et al [43], the nurses had the highest practice scores for HCW while the medical doctors and the domestic staff had the lowest practice scores. It was founded that nurses had better attitudes towards separation of wastes, proper disposal than did technicians and housekeeping staff [44]. On the other hand, Mostafa et al noted poor practices scores among nurses and doctors for HCW [33]. The inadequate practices among doctors might be due to patient overload, inadequate supplies, and lack of interest in participating to the waste management programs.

CONCLUSION
Despite the lack of data concerning the rate of occupied beds and the daily volume of waste generated by the surveyed hospitals, our results showed that healthcare professionals have the highest knowledge, perceptions, and practices while the staff that cleans the hospital and collects wastes has the lowest. Medical personnel could significantly reduce transmission by ensuring that medical waste is placed into the proper bins. All categories of healthcare workers practicing in Lebanon should have ongoing training on MWM in order to prevent personnel, patient, community, and environmental hazards. Policy and regulation guidelines should be provided to all of the hospital's staff to improve waste management practices throughout the country.

Abbreviations
GB: Greater Beirut
HCV: Hepatitis C Virus
HIV: Human Immunodeficiency Virus
HCW: Healthcare waste
HCWM: Healthcare Waste Management
IHCW: Infectious Healthcare Waste
MW: Medical Waste
MWM: Medical Waste Management
WHO: World Health Organization
WMO: Waste Management officer

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