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Evaluating of Medical Waste Disposal Process in Hospitals

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Abstract

Medical waste is defined by the World Health Organization as waste produced by medical procedures and includes a wide range of items, including used needles and syringes, soiled dressings, body parts, diagnostic samples, blood, chemicals, etc. the aim of the current study was to evaluate medical waste disposal process practices among healthcare workers in some hospitals in Mosul, Iraq and to estimate the safety practice and perception among waste-exposed personnel for the exposure hazards. A cross-sectional study was performed in Mosul city was designed and being set to investigate the perceptions on medical waste disposal process management, among medical staff (n=642) and workers-related to medical service providing (n=60) in their working hospitals. Observation checklist in hospitals were used to verify the acquired data. Results revealed that The old incinerators do not contain filters to purify the gases generated from the chimney, and thick black smoke is observed that comes out of the burning and works at random times. Those working in waste incineration do not have sufficient experience, and for this reason it is well noted that they do not wear protective equipment to protect themselves from the dangers of burning and heat. Conclusively, the current study pinpoints on the urgent needs for allocating a proper strategy for medical waste disposal management with clear plans and policies for the proper management in hospitals of Mosul city. Proper education and training must be offered to all workers from doctors to rag pickers to ensure an understanding of the risks that wastes pose and how to manage wastes. The study was conducted from February to September 2022.

Keywords: medical waste, disposal process, waste disposal practices, safety for waste disposal.

Introduction

Hospitals are medical facilities that offer patient treatment. Healthcare facilities and hospitals are responsible for the general public's health. This can be accomplished either directly or indirectly by providing a clean and healthy environment for their employees and the community. Sharps, human tissues or body parts, and infectious materials are among the most common types of healthcare waste [1,6]. hospital waste management refers to the control of disease transmission through the management of trash generated by hospitals. Hospital waste management, including its segregation, collection, storage, transportation, and disposal, is poorly understood in developing nations. Ample regulation, funding, and the active engagement of knowledgeable and educated people are all necessary for effective management of healthcare waste. All those who are exposed to hazardous waste could be at risk. Those in the medical profession, hospital patients, hospital visitors, hospital staff (laundry, waste handlers and transporters), and employees of waste disposal facilities like landfills or incinerators, including scavengers, are the main groups at risk. Although there are many illnesses that can be passed from person to person, hepatitis B, hepatitis C, and AIDS are the most serious [2].

The World Health Organization (WHO) defines medical waste (healthcare) as all the wastes generated within healthcare facilities, research centers, and laboratories related to medical procedures, e.g., used syringes, needles, metal sharps, dressings, blood samples, body parts, pharmaceutical, chemical, radioactive materials, and devices, as well as from minor and scattered sources, including bacterial and organism wastes produced in the course of healthcare undertaken in the home. [10]. According to the World Health Organization (2000), about 80% of the total waste generated by healthcare activities is general trash, which is comparable to home waste. The remaining about 20% of wastes are classified as hazardous materials because they can be radioactive, poisonous, or contagious. [11]. The World Health Organization (WHO) has divided medical waste into the following types: a) Infectious: substance containing pathogens in concentrations sufficient to induce disease upon exposure. This comprises surgical trash, lab cultures, discarded dressings, and others. b) Sharps include disposable needles, syringes, knives, and shattered glasses. c) Pathological elements include tissues, organs, body parts, human flesh, blood, and bodily fluids. d) Pharmaceuticals include medications and chemicals that have been returned, spilled, expired, or contaminated. e) Chemical: waste from diagnosis or cleaning materials. f) Radioactive: waste polluted with radioactive compounds used to diagnose and cure diseases. g) Pressurized containers, including gas cylinders; h) Heavy metal-containing substances, such as shattered mercury thermometers and blood pressure gauges. The most common categories of medical waste are infectious, pathological, and sharps. [14]. Hospital waste management is the process of controlling disease spread by managing the trash generated by hospitals. Hospital waste management, which includes segregation, collection, storage, transportation, and disposal, is poorly understood in underdeveloped countries. Effective healthcare waste management requires enough legislation, money, and the active participation of skilled and educated people. [11]. There are many steps of medical waste management : firstly segregation step secondly collection and storage step the next step transportation finally disposal step.

Disposal is a critical stage in the process of safely treating medical waste. This is the process of carefully and responsibly treating garbage until it is no longer contagious and then appropriately disposed of. The final selection of the treatment regimen must be made carefully on the basis of various factors of these foundations: the quantity and types of waste to be treated and disposed of, processing capacity of the treatment system, processing efficiency, health and environmental conditions, and reducing the volume and mass of waste. Occupational safety and health issues, infrastructure needs, processing skills, and local technology availability. Final disposal options, Training needed to operate the selected method, Operation and maintenance considerations, There is available room. The location of the treatment area and disposal facility, as well as its surroundings, Investment and operating costs. General Admission [9]. Medical waste can be treated with moist heat using autoclave sterilization, followed by final disposal of ash and residues in safe pits or landfills located outside the health facility. If the temperature and contact time are high enough, this technique effectively kills most bacteria. Bacterial spores require a temperature of at least 121 degrees Celsius to be killed, as this temperature is estimated to prevent 99.99% of germ activity [9].

Shredding is a technique that reshapes or cuts garbage into tiny pieces, making it unrecognizable. It aids in the prevention of reuse of bio-medical waste and serves as an indicator that the wastes have been disinfected and are safe to dispose of. A shredder is to be used for shredding medical waste with the minimum standards. [10]. Microwave sterilization

is the third most common medical waste treatment procedure in the world. It destroys most microorganisms using microwaves with a frequency of 2450 MHz. It has a wavelength of 12.24 cm. The garbage is crushed into a container and passed through a funnel. Microwaves rapidly heat the water inside the waste, while thermal conductivity destroys the pathogenic components. Microwaves shred waste till it is little. After that, the trash is moistened and moved to an irradiation room equipped with a series of microwave generators, where it is subjected to waves for 20 minutes [9]. Incineration in high-temperature ovens, as depicted, can also be used to dispose of medical waste. Incineration is a process of dry oxidation at high temperatures that converts organic and combustible trash to inorganic non-combustible elements, resulting in a large reduction in waste volume and weight. This method is used to handle waste that cannot be recycled, reused, or disposed of in a landfill. The Burning Chamber: In that room, the garbage is incinerated and burned using the whole combustion process, and the temperature in that room must not be less than 850 degrees Celsius. [9,15].

Sanitary burial (landfill) of untreated hazardous medical waste is also employed. There are two types of land disposal in emerging countries: uncontrolled and controlled. As the term implies, uncontrolled land disposal (also known as open dumping) is not managed and is therefore unacceptable. Open dumps have no regulations in place to prevent unwanted access or environmental pollution. The options range from small pits to modern sanitary landfills (which are centrally located). These options offer enhanced controls and site security [13]. Medical trash that has been previously shredded, coated, or sterilized may be disposed of as domestic or semi-domestic garbage. A modest private burial pit can be set up to accept exclusively healthcare waste. [9]. State of the Problem including poor management and a lack of awareness among health-care staff about medical waste disposal methods and management can lead to a variety of major health problems that immediately harm public health. And Hospitals and healthcare providers must identify gaps and implement new procedures to decrease risks, improve performance, and build effective medical waste management plans.

Aim of the work are General objective to assess medical waste disposal processes among health-care workers in several Mosul hospitals, as well as to estimate waste-exposed personnel's safety procedures and perceptions of exposure hazards. And Specific Objectives are Determine the present degree of medical waste disposal methods among healthcare personnel in Mosul, Iraq. To assess healthcare personnel' perceptions of medical waste disposal hazards. To identify the barriers to the implementation of effective occupational safety practices as a strategic instrument for improving health-care worker performance in the selected hospitals.

Material and Methods

Study Design

A cross-sectional study was conducted in Mosul, Iraq, to assess the condition of medical waste disposal management in three selected institutions that agreed to participate in the study: Al-Salam Hospital, Ibn Sina Hospital, and Mosul General Hospital. The study was conducted from February to September 2022.

Study Setting

The study was planned and is being carried out to explore the perceptions of medical waste disposal management among a sample of medical personnel and workers who provide medical services in their working hospitals. Each hospital utilized an observation checklist to verify the data collected. To conduct the study, certain administrative affiliations were completed and submitted to the Directorate of Health Affairs as well as the targeted hospitals' administration. The trial ran from February to September 2022.

Study Sample

The study sample consisted of 642 medical professionals and 60 workers associated to medical service provision who agreed to participate in the study at the participating facilities.

Study tools

Based on a literature search, self-designed questionnaires were used to examine medical waste disposal management practices in the target institution. A questionnaire was devised to target the practices of medical professionals, while another targeted the practices of workers involved in medical service delivery. The observation checklist was similarly built to cover this process. In order to check the data collected in each institution.

Validation Analysis

Following data collection, it was reviewed, coded, and fed into the statistical program IBM SPSS version 20 to test reliability and validity in the study sample. Cronbach's test was used to determine dependability. A validation assessment was also undertaken. The comparative fit index and non-normed fit index were used to assess the goodness of data fit.

Data collection

Data were collected using the predefined questionnaires. The researcher conducted site visits to gather information on various areas of medical waste disposal management methods in the target hospital. Each hospital utilized an observation checklist to verify the data collected. Observation was carried out by visiting the hospital four times on different days to confirm the accuracy of the data.

Ethical clearance

Participants provided oral agreement at the start of data collection after being informed of the study's aims and assured of confidentiality. Everyone had the option to withdraw from the research at any moment.

Statistical analysis

After that, the data were put into IBM SPSS version 20. The graphs shown were created using Microsoft Excel program. All statistical analysis was performed using two-tailed tests with an alpha error of 0.05. A P value of less than or equal to 0.05 was considered statistically significant.

Results and Discussion

A cross-sectional study was conducted in Mosul, Iraq, to look into the status of medical waste disposal management in three hospitals that agreed to participate in the study. The study was planned and is currently underway to explore the perceptions of medical waste disposal management among medical professionals (n=642) and workers associated to medical service provision (n=60) in their respective institutions. Each hospital utilized an observation checklist to verify the data collected.

Comparative analysis of safety practices related to management of medical waste disposal in the selected hospitals

Waste disposal step in the selected hospitals

Table 1. shows a comparative analysis of the application of practices in waste disposal step as perceived by medical staff in the selected hospitals. For the statement of using color distinguishing for labeling in waste disposal, it was confirmed by 60.3% in hospital 1, 55.8% in hospital 2, and 72.1% in hospital 3, while it was denied by 10.2% in hospital 1, 8.2% in hospital 2, and 12.1% in hospital 3. However, 29.5% in hospital 1, 36% in hospital 2, and 15.8% in hospital 3, did not know about it. Chi-square test showed statistical significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.000$. The result was confirmed by ANOVA, which showed statistical significant difference at $P < 0.000$.

As illustrated in Table 1, for the statement about the type of containers used in waste disposal, it was stated that it is being transported within plastic containers by 90.5% in hospital 1, 88.9% in hospital 2, and 90.5% in hospital 3, and it was stated that it is being transported within metal containers by 3.7% in hospital 1, 8.2% in hospital 2, and 6.9% in hospital 3, while 5.8% in hospital 1, 2.9% in hospital 2, and 2.6% in hospital 3, did not know about it. Chi-square test showed statistical non-significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.113$. The result was confirmed by ANOVA, which showed statistical non-significant difference at $P < 0.777$.

For the statement of whether there is a special place for waste disposal outside the hospital, it was confirmed by 42.6% in hospital 1, 49% in hospital 2, and 45.2% in hospital 3, while it was denied by 4.1% in hospital 1, 7.2% in hospital 2, and 19% in hospital 3. However, 53.3% in hospital 1, 43.8% in hospital 2, and 35.8% in hospital 3, did not know about it. Chi-square test showed statistical significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.000$. The result was confirmed by ANOVA, which showed statistical significant difference at $P < 0.043$ (Table 1).

For the statement of how many times the waste is being incinerated, it was stated that it is being incinerated daily by 30.7% in hospital 1, 25.5% in hospital 2, and 36.8% in hospital 3, and it was stated twice a week by 6.7% in hospital 1, 8.2% in hospital 2, and 21.6% in hospital 3, while it was stated once a week by 3.3% in hospital 1, 5.8% in hospital 2, and 4.2% in hospital 3, and 59.4% in hospital 1, 60.5% in hospital 2, and 37.4% in hospital 3, did not know about it. Chi-square test showed statistical significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.000$. The result was confirmed by ANOVA, which showed non-statistical significant difference at $P < 0.000$ (Table 1).

For the statement of whether there is a standard working incinerator within the hospital, it was confirmed by 74.6% in hospital 1, 77.4% in hospital 2, and 85.8% in hospital 3, while it was denied by 4.4% in hospital 1, 12% in hospital 2, and 6.9% in hospital 3. However, 21% in hospital 1, 10.6% in hospital 2, and 7.3% in hospital 3, did not know about it. Chi-square test showed statistical significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.000$. The result was confirmed by ANOVA, which showed statistical significant difference at $P < 0.001$ (Table 1).

For the statement concerning about the status of incinerator, it was stated that it is being good by 30.7% in hospital 1, 20% in hospital 2, and 31.6% in hospital 3, and it was stated good to some extent by 21.7% in hospital 1, 28% in hospital 2, and 23.7% in hospital 3, while it was stated moderate by 33.6% in hospital 1, 34.1% in hospital 2, and 32.6% in hospital 3, it was stated bad by 4.5% in hospital 1, 12% in hospital 2, and 5.3% in hospital 3, and it was stated too bad by 9.4% in hospital 1, 5.8% in hospital 2, and 6.8% in hospital 3. Chi-square test showed statistical significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.009$. The result was confirmed by ANOVA, which showed statistical significant difference at $P < 0.04$ (Table 1).

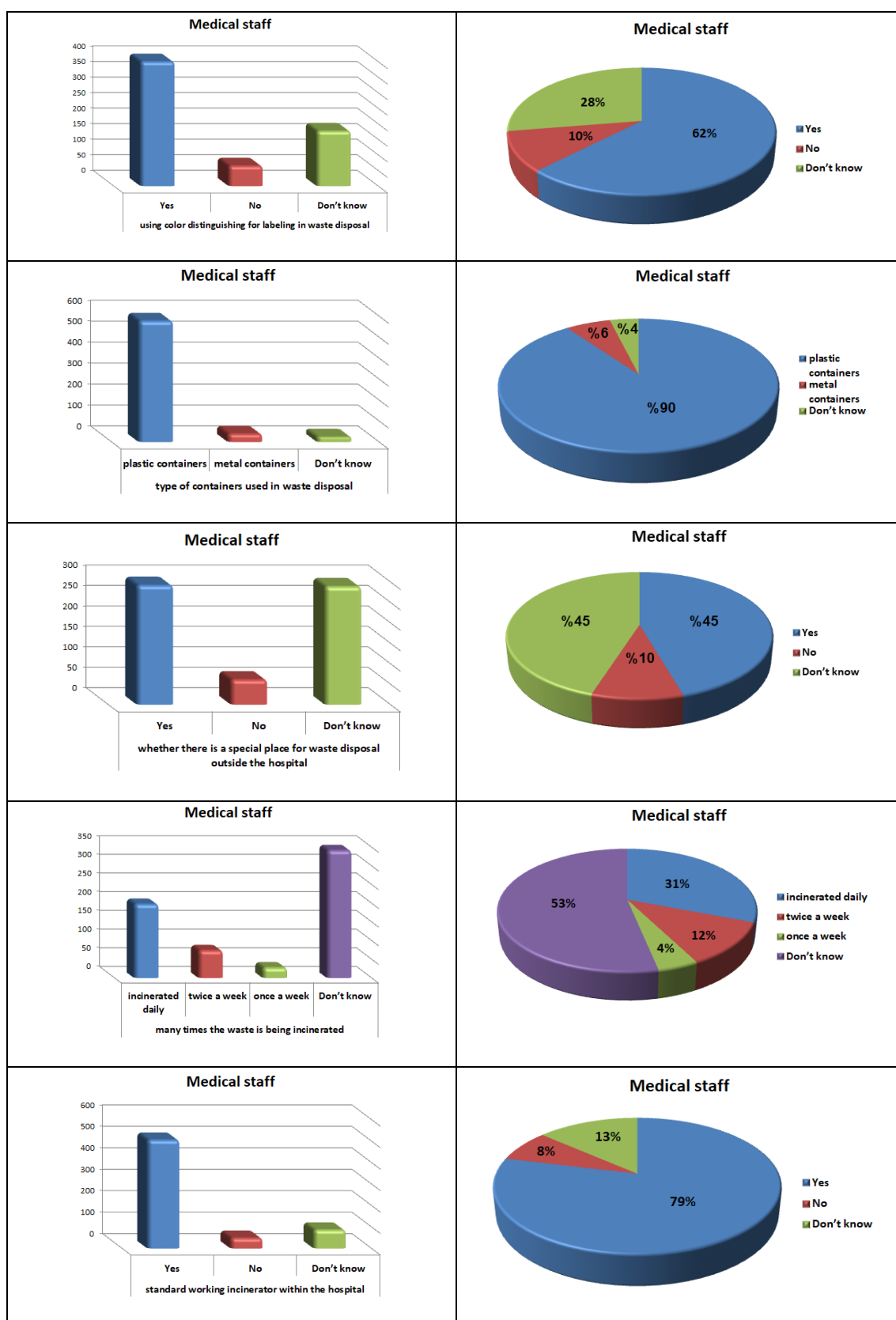
Table 1. A comparative analysis of the application of practices in waste disposal step in the selected hospitals as perceived by medical staff.

State	Variable	Response	Perceptions of workers						Statistical test	P-Value
			Hospital 1 n=244		Hospital 2 n=208		Hospital 3 n=190			
			No	%	No	%	No	%		
waste disposal step	Using color distinguishing for labeling in waste disposal	Yes	147	60.3	116	55.8	137	72.1	$\chi^2=21.375^{**}$	0.000<
		No	25	10.2	17	8.2	23	12.1		
		Don't know	72	29.5	75	36	30	15.8		
		Min.- Max.	1-3		1-3		1-3		F=9.167**	0.000<
		Mean ± SD.	2.307±0.898		2.197±0.940		2.563±0.752			
	The type of containers used in waste disposal	plastic containers	221	90.5	185	88.9	172	90.5	$\chi^2=7.471$	0.113>
		metal containers	9	3.7	17	.82	13	6.9		
		Don't know	14	5.8	6	.29	5	2.6		
		Min.- Max.	1-3		1-3		1-3		F=0.253	0.777>
		Mean ± SD.	2.848±0.494		2.861±0.423		2.879±0.399			
	Whether there is a special place for waste disposal outside the hospital	Yes	104	42.6	102	49	86	45.2	$\chi^2=34.874^{**}$	0.000<
		No	10	4.1	15	7.2	36	19		
		Don't know	130	53.3	91	43.8	68	35.8		
		Min.- Max.	1-3		1-3		1-3		F=3.798*	0.043<
		Mean ± SD.	1.893±0.975		2.053±0.964		2.095±0.898			
	How many times the waste is being incinerated	daily	75	30.7	53	25.5	70	36.8	$\chi^2=42.521^{**}$	0.000<
		twice a week	16	6.7	17	8.2	41	21.6		
		once a week	8	3.3	12	5.8	8	4.2		
		Don't know	145	59.4	126	60.5	71	37.4		
		Min.- Max.	1-4		1-4		1-4		F=11.19**	0.000<
		Mean ± SD.	2.086±1.375		1.986±1.309		2.579±1.318			

	Whether there is a standard working incinerator within the hospital	Yes	182	74.6	161	77.4	163	85.8	$\chi^2=26.744^{**}$	0.000<
		No	11	4.4	25	12	13	6.9		
		Don't know	51	21	22	10.6	14	7.3		
		Min.- Max. Mean \pm SD.	1-3 2.537 \pm 0.818		1-3 2.668 \pm 0.659		1-3 2.784 \pm 0.564		F=6.748**	0.001<
	Concerning about the status of incinerator	good	75	30.7	42	20	60	31.6	$\chi^2=20.325^{**}$	0.009<
		good to some extent	53	21.7	58	27.9	45	23.7		
		moderate	82	33.6	71	34.1	62	32.6		
		bad	11	4.5	25	12	10	5.3		
		too bad	23	9.4	12	5.77	13	6.8		
		Min.- Max. Mean \pm SD.	1-5 3.598 \pm 1.232		1-5 3.447 \pm 1.115		1-5 3.679 \pm 1.172		F=3.15*	0.04<

*Mean was calculated for the given scores of the suggested question. Scores were given 3 for the answer of YES, 2 for the answer of NO, and 1 for the answer of don't know.

X²: Chi-square test was confirmed by F-test, ANOVA, at significant level of $p \leq 0.05$.



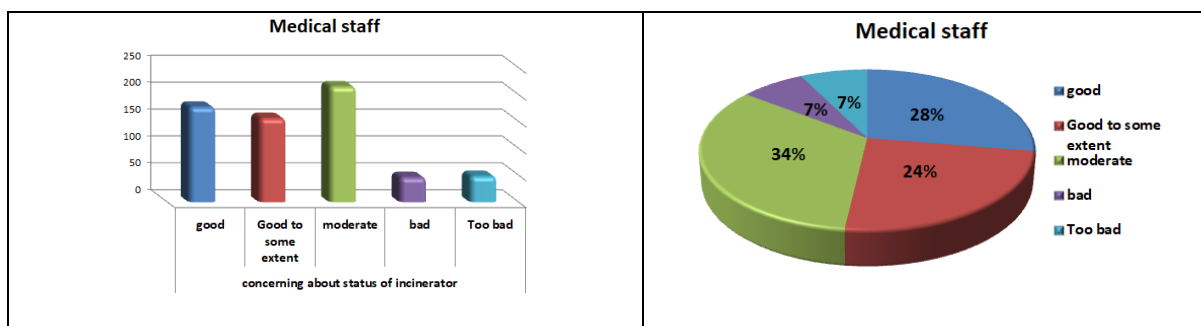


Figure 1. The descriptive analysis of practices in waste disposal step as perceived by medical staff in the selected hospitals.

Table 2. shows practices in waste disposal step as perceived by workers-related to medical service providing in the selected hospitals. For the statement about the type of containers used in waste disposal, it was stated that it is being transported within plastic containers by 100% in hospital 1, 93.8% in hospital 2, and 100% in hospital 3, and it was stated that it is being transported within metal containers by 0.0% in hospital 1, 6.2% in hospital 2, and 0.0% in hospital 3. Chi-square test showed statistical non-significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.247$. The result was confirmed by ANOVA, which showed statistical non-significant difference at $P < 0.257$.

As illustrated in Table 4.12, for the statement of the type of methods used for waste disposal inside the hospital, it was stated landfill by 0.0% in hospital 1, 0.0% in hospital 2, and 33.3% in hospital 3 and it was stated incineration by 100% in hospital 1, 93.8% in hospital 2, and 66.7% in hospital 3, while it was stated via shredding by 0.0% in hospital 1, 6.2% in hospital 2, and 0.0% in hospital 3. Chi-square test showed statistical significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.003$. The result was confirmed by ANOVA, which showed statistical significant difference at $P < 0.001$.

For the statement of how many times the waste is being incinerated, it was stated that it is being incinerated daily by 85% in hospital 1, 81.3% in hospital 2, and 58.3% in hospital 3, and it was stated twice a week by 5% in hospital 1, 6.2% in hospital 2, and 20.8% in hospital 3, while it was stated once a week by 0.0% in hospital 1, 12.5% in hospital 2, and 4.2% in hospital 3, and 10% in hospital 1, 0.0% in hospital 2, and 16.7% in hospital 3 did not know about it. Chi-square test showed statistical non-significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.141$. The result was confirmed by ANOVA, which showed statistical non-significant difference at $P < 0.210$ (Table 2).

As illustrated in Table 2, for the statement of how is the disposal of fluid medical waste, it was stated directly through regular sanitary disposal by 35% in hospital 1, 50% in hospital 2, and 16.7% in hospital 3, and it was stated through regular sanitary disposal after treatment by 20% in hospital 1, 6.2% in hospital 2, and 12.5% in hospital 3, while 45% in hospital 1, 43.8% in hospital 2, and 70.8% in hospital 3, did not know about it. Chi-square test showed statistical non-significant difference between the studied hospitals for practices in disposal step of medical waste at $P < 0.160$. The result was confirmed by ANOVA, which showed statistical non-significant difference at $P < 0.304$. Figure 4.17 illustrates the descriptive analysis of practices in waste disposal step as perceived by workers related to medical service providing in the selected hospitals.

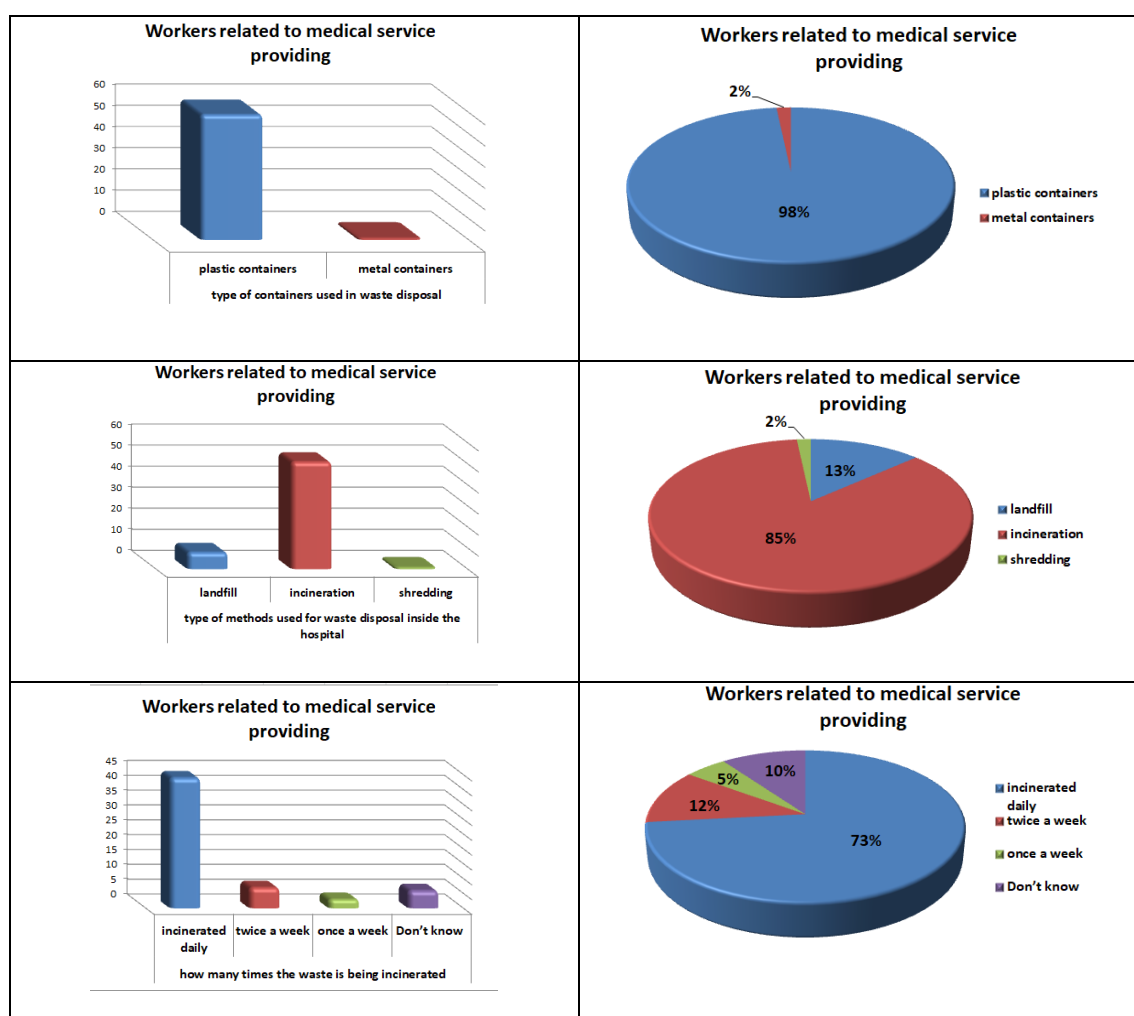
Table 2. A comparative analysis of the application of practices in waste disposal step in the selected hospitals as perceived by workers-related to medical service providing.

State	Variable	Response	Perceptions of workers						Statistical test	P-Value
			Hospital 1 n=244		Hospital 2 n=208		Hospital 3 n=190			
			No.	%	No.	%	No.	%		
waste disposal step	Type of containers used in waste disposal	plastic containers	20	100	15	93.8	24	100	$\chi^2=2.797$	0.247>
		metal containers	0	0	1	6.2	0	0		
		Do not know	0	0	0	0	0	0		
		Min.- Max.	3-3		2-3		3-3		F=1.393	0.257>
		Mean ± SD.	3±0.000		2.938±0.250		3±0.000			
	Type of methods used for waste disposal inside the hospital	landfill	0	0	0	0	8	33.3	$\chi^2=16.373^{**}$	0.003<
		incineration	20	100	15	93.8	16	66.7		
		shredding	0	0	1	6.2	0	0		
		Min.- Max.	2-2		1-3		2-3		F=8.692**	0.001<
		Mean ± SD.	2±0.000		2.063±0.250		1.667±0.482			
	How many times the waste is being incinerated	incinerated daily	17	85	13	81.3	14	58.3	$\chi^2=9.637$	0.141>
		twice a week	1	5	1	6.2	5	20.8		
		once a week	0	0	2	12.5	1	4.2		
		Don't know	2	10	0	0	4	16.7		
		Min.- Max.	1-4		2-4		1-4		F=1.605	0.210>
	Mean ± SD.	1.350±0.933		1.313±0.704		1.517±0.983				
	how is the disposal of fluid medical waste	directly through regular sanitary disposal	7	35	8	50	4	16.7	$\chi^2=6.581$	0.160>
		through regular	4	20	1	6.2	3	12.5		

		sanitary disposal after treatment								
		Don't know	9	45	7	43.8	17	70.8		
		Min.- Max.	1-3		1-3		1-3		F=1.214	0.304>
Mean ± SD.	1.750±0.786		1.625±0.619		1.417±0.717					

*Mean was calculated for the given scores of the suggested question. Scores were given 3 for the answer of YES, 2 for the answer of NO, and 1 for the answer of don't know.

X²: Chi-square test was confirmed by F-test, ANOVA, at significant level of $p \leq 0.05$.



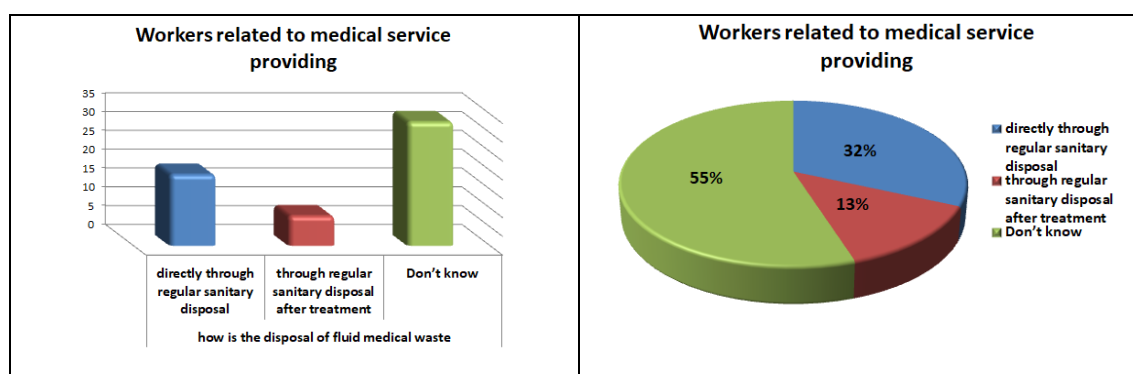


Figure 2. The descriptive analysis of practices in waste disposal step as perceived by workers-related to medical service providing in the selected hospitals.

Analysis of observation checklist on practices related to medical waste

Table 3 shows the analysis of observation checklist on practices related to disposal of medical waste in the studied hospitals (Al-Salam Hospital, Ibn Sina Hospital, and Mosul General Hospital.). It was observed that there is sometimes color distinguishing for labeling in waste disposal in contrast to perceptions of health-related personnel who stated that always there is color distinguishing. It was observed that there is a special place not suitable for waste disposal outside the hospital. It was observed that there is a bad working incinerator within the hospital in contrast to perceptions of health-related personnel who stated that there is moderate working incinerator. It was also observed that there is no a pre-treatment for hazardous medical waste before disposal in contrast to perceptions of health-related personnel who stated that there is a pretreatment. It was further observed that the disposal of fluid medical waste is being mostly performed directly through regular sanitary disposal except for Hospital 1 which treat the fluid waste before disposal. For the observation of whether disposal of medical waste suits public and environmental health, it was observed that there is no any good plan for disposal of waste. For the observation of whether there is an open damp place for disposal of the medical waste near the hospital, it was observed that there is a place out of standards being used in contrast to perceptions of health-related personnel who stated that there is no any place.

Table 3. Analysis of observation checklist on practices related to disposal of medical waste in the studied hospitals.

State	Variable	Response	Hospital 1		Hospital 2		Hospital 3		Overall	
			No.	%	No.	%	No.	%	No.	%
waste disposal step	There is sometimes color distinguishing for labeling in waste disposal	Always	1	25	2	50	1	25	4	33.3
		Sometime	2	50	1	25	2	50	5	41.7
		Rarely	1	25	1	25	1	25	3	25
		Sum of Ob. Mean \pm SD.	12 3 \pm 0.82		13 3.25 \pm 0.96		12 3 \pm 0.82		37 3.08 \pm 0.87	
	There is a special place for waste disposal outside the hospital	Very suitable	2	50	0	0	0	0	2	16.7
		Suitable	1	25	1	25	2	50	4	33.3
		Not suitable	1	25	3	75	2	50	6	50
		Sum of Ob. Mean \pm SD.	9 2.25 \pm 0.96		5 1.25 \pm 0.5		6 1.5 \pm 0.58		20 1.67 \pm 0.68	
	The incinerator	Good	1	25	1	25	1	25	3	25

	in hospital	Moderate	2	50	0	0	0	0	2	16.7
		Bad	1	25	3	75	3	75	7	58.3
		Sum of Ob. Mean \pm SD.	7 1.75 \pm 0.96		9 2.25 \pm 0.5		9 2.25 \pm 0.5		25 2.08 \pm 0.65	
	A pre-treatment for hazardous medical waste before disposal	Yes	0	0	0	0	1	25	1	8.3
		Sometime	0	0	1	25	0	0	1	8.3
		No	4	100	3	75	3	75	10	83.3
		Sum of Ob. Mean \pm SD.	4 1 \pm 0.00		5 1.25 \pm 0.5		6 1.5 \pm 1		15 1.25 \pm 0.5	
	The disposal of fluid medical waste	Directly through regular sanitary disposal	1	25	3	75	4	100	8	66.7
		Regular sanitary disposal after treatment	3	75	1	25	0	0	4	33.3
		Sum of Ob. Mean \pm SD.	6 1.5 \pm 0.58		7 1.75 \pm 0.96		11 2.75 \pm 0.5		24 2 \pm 0.68	
	whether disposal of medical waste suits public and environmental health	Correct	1	25	1	25	2	50	4	33.3
		Incorrect	3	75	3	75	2	50	8	66.7
		Sum of Ob. Mean \pm SD.	5 1.25 \pm 0.5		5 1.25 \pm 0.5		6 1.5 \pm 0.58		16 1.33 \pm .053	
	whether there is an open damp place for disposal of the medical waste near the hospital	Yes	3	75	4	100	2	50	9	75
		No	1	25	0	0	2	50	3	25
		Sum of Ob. Mean \pm SD.	7 1.75 \pm 0.5		8 2 \pm 0.00		6 1.5 \pm 0.58		21 1.75 \pm .036	

*Observation was performed by visiting the hospital four times on separate days to ensure the quality of the acquired data.

Discussion

The current study was aimed to look into the state of medical waste disposal in three hospitals in Mosul, Iraq. The study was planned and is being conducted to explore the perceptions of medical waste disposal management, from segregation to final disposal, among medical staff (n=642) and workers associated to medical service providers (n=60) in their respective institutions. The obtained data was verified using an observation checklist and conversations with managers at each facility. In terms of medical waste disposal methods, it was discovered that color differentiating is sometimes used for labeling, contrary to the opinions of health-care staff who believed that color distinguishing is usually present. It was discovered that there is a special area outside the hospital that is not suited for garbage disposal. It was discovered that the operational status of the incinerator was poor, in contrast to the perceptions of health-care personnel, who said that it was moderate.

Disposal process

The disposal process is regarded as the most crucial stage of medical waste management in healthcare facilities, as its effectiveness ensures the success of dealing with this sort of trash on a wide scale. As the operations at this stage are effectively handled, they will assure the removal of pathogens connected with hazardous waste, as well as a significant reduction, if not elimination, of dangers. Eliminating these hazards benefits both public health and the surrounding environment by protecting it from any concerns posed by medical waste. Indifference to the issues confronting hospitals and healthcare facilities is the polar opposite. As a result, advanced methods and procedures must be employed for each form of waste generated by the hospital department, in accordance with the standards established by worldwide health and environmental organizations. Medical waste can be disposed of in a variety of ways, such as burning, microwave, autoclaving, and landfilling. [9,10].

The current results showed that the commencement of the placement of waste in open yards, one of which has an incinerator, which is the basic technique of treatment and nearly the only one. The garbage collection facility for incineration is not qualified for this function, hence rubbish accumulates at random in the area. The incinerator's location is unusual because it is close to hospital departments and residential areas, as well as units near the hospital that have been affected by emissions from the chimney, and all of them have complained about the smoke that affects them significantly. The ancient incinerators lack filters to purify the gases emitted by the chimney, resulting in dense black smoke that flows out of the burning and functions intermittently. Those working in waste incineration lack proper experience, and it is worth noting that they do not wear protective equipment to protect themselves from the dangers of burning and high temperatures. Furthermore, officials have very little monitoring of the incinerators, which exacerbates the situation why this is attributed to officials' interest in the field of the environment and its risks is very little, as they do not take into account the negatives and damages that may be generated by waste and disposing of it in a safe manner, which may therefore reflect negatively on human health and the environment. In addition, they do not have sufficient awareness of the dangers of disposing of medical waste, and the necessary experience was not effectively present, as all they know is collecting waste and stacking it to burn it. . In terms of other medical waste disposal devices, only the autoclave was detected, which is one of the positive aspects of disposal operations to save the environment, although the majority of them do not work. Furthermore, even if it is discovered to work, it frequently fails, and it is terrible that there are no engineers or people in charge of these devices who are trained in how to handle and maintain them. Similarly, the number of service personnel is limited, and they lack experience dealing with it, causing it to be disrupted and costing the health directorates a lot of money to repair or find alternatives.

One of the most essential aspects that must be evaluated in order to develop them and improve their performance is the open landfill, which is subject to burning and gas emissions. Because it is not constructed in compliance with international regulations, it is one of the most harmful medical waste disposal techniques and should be avoided at all costs. The findings align with those of Marinković et al. (2008)⁸ and Gyasi (2020)⁷. Marinković et al. (2008)⁸ did a study in Croatia and showed that landfilling is the major way of disposal. However, the authors believe that incineration is the most appropriate approach. Gyasi (2020)⁷, who did a study in Ghana, stated that incineration is still the primary technique of treatment in Ghanaian hospitals, and that new approaches, such as engineering, are necessary to reduce its environmental impact.

Conclusions

1. A cross-sectional study was conducted in Mosul, Iraq, to look into the status of medical waste disposal management in three hospitals that agreed to participate in the study. The study was planned and is being conducted to explore the perceptions of medical waste disposal management, from segregation to final disposal, among medical staff (n=642) and workers associated to medical service providers (n=60) in their respective institutions. The obtained data was verified using an observation checklist and conversations with managers at each facility.

2. Some medical waste disposal practices use color-coding for labeling, despite health-care personnel's belief that it is always done. It was also discovered that there is a unique area outside the hospital that is not suitable for garbage disposal. The operational status of the incinerator was seen to be poor, contrary to the perceptions of health-care staff, who said that it is moderate. It was also discovered that there is no pre-treatment for hazardous medical waste before disposal, contrary to the perceptions of health-care workers who claim that there is. It was also discovered that the majority of fluid medical waste is disposed of immediately using conventional sanitary disposal, with the exception of Hospital 1, which processes the fluid waste before disposal. It was discovered that there is no good garbage disposal plan that is both public and environmentally friendly. It was discovered that a location outside of norms is being used for medical waste disposal, contrary to the beliefs of health-care staff who said that there is no such place.

Recommendations

1. **Create a safe disposal and recycling infrastructure for hazardous materials:** Hospitals should prioritize pollution avoidance and use less hazardous products, independent of the presence of a hazardous waste business.
2. **Create a safe infrastructure for disposing of municipal solid waste:** To protect the country's public health, sanitary landfills, sewage treatment plants, and other waste management facilities must be built, allowing for the ultimate safe disposal of wastes that cannot be recycled, composted, or reused. Proper pollution prevention, combined with a clear definition of the problem and purpose, will result in the best, most ecologically friendly, and cost-effective waste disposal solution. Healthcare facilities must be able to integrate into a municipal waste management system in order to fulfill their purpose of providing for public health.

Author Contributions Statement

All research stage: laboratory work, collection and analysis of data, research write were done by the authors

Declaration of competing interest

The authors declare that there were no competing interests.

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