

Knowledge and Practices of Nursing Staff Regarding Biomedical Waste Management at Rural Health Units in Tanta City

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Abstract:

Background: Biomedical waste is unwanted materials that contains potentially infectious elements and produced during medical procedures such as diagnosis, therapy, surgery, vaccination, or research. Healthcare waste poses serious dangers to public health and the environment, making its management crucial. **This study** aimed to assess knowledge and practices of nursing staff regarding biomedical waste management at rural health units in Tanta city. **Research design:** Descriptive study design was utilized to achieve the aim of this study. **Setting:** This study was conducted at 14 rural health units affiliated to Tanta district. **Sample:** All the available nursing staff working (325) at the previous mentioned settings was included in this study. **Tool of the study:** A structured questionnaire sheet was used including three parts: (1) Socio-demographic characteristics of the studied nursing staff, (2) Nurses' knowledge regarding biomedical waste and its management (3) Self-reported practices of nursing staff regarding biomedical waste management. **Results:** 43.4% nurses who were studied knew very little about biomedical waste management and 60.6% had unsatisfactory reported practice. **Conclusion:** Highly a statistically significant positive association between the study nurses' overall knowledge score and their overall reported practice score regarding biomedical waste management ($p < 0.001$). **Recommendation:** It is essential to identify nurses training needs regarding safe waste management policies and guidelines through ongoing evaluation of nurses' expertise and methods in waste control in health care units.

Keywords: Biomedical waste management, Knowledge, Nursing staff, Practices and Rural health units

Introduction

Health care settings are health institutions that provide patient care services. Globally, there was a constant increase and expansion in the number of health care institutions and hospitals to meet the health care services required of the alarming population expansion. An increase and expansion in the number of hospitals and health care facilities (HCF),

causes an increase in the utilization of disposable medical materials, which further contributed in production of a large amount of biomedical wastes in these medical facilities. Additionally, the development of increasingly sophisticated medical technology and equipment leads to a rise in waste output. (Chand et al., 2021).

In the process of healthcare delivery, many wastes are generated. Such waste includes soiled cotton, bandages, hypodermic needles, syringes, tubing such as intravenous sets, and urinary catheters etc. which constitutes merely 15% of total waste generated in a hospital and have the potential to cause harm to human beings and environment. The remaining 85% is considered general non-hazardous waste such as waste paper, wrapper of drugs, cardboard and left-over food (Capoor & Parida, 2021b)

It is the duty of the health care settings to take care of public health sites directly through providing patient care or indirectly by ensuring clean and healthy environment. Medical wastes pose a significant risk to human health and the environment, making them extremely important. This type of waste includes radioactive or genotoxic compounds, heavy metals, toxic chemicals, and infectious waste. (Thakre, 2019).

Hospitals and other health care facilities, laboratories and research centers mortality and autopsy centers, animal research and testing laboratories, blood banks and nursing homes for the elderly are the major source of health care wastes. Health care waste or medical waste is any solid or liquid waste that generated during diagnoses, treatment, and immunization or during medical research. It includes all types of wastes produced by health care facilities (Dihan et al., 2023).

Medical wastes may be classified into different types according to the source, type, risk factors associated with their handling, storage and disposal.

Medical wastes cover a diverse range of materials. According to World Health Organization (WHO) 2018, medical wastes is divided into eight groups: general wastes , pathological waste, radioactive waste, chemical waste, infectious waste, sharps, pharmaceutical waste and cytotoxic waste (Abhishek, Singh, Gupta, Agrawal, & Soni, 2023).

Biomedical waste is unwanted materials that contains potentially infectious elements and produced during study, diagnosis, therapy, surgery, or vaccination activities. It includes all the materials used while administering treatment to patients as well as all items contaminated by hazardous fluids, as blood, urine, feces, and other body fluids. It may be infectious to anyone who contact with it and includes sharps, human tissues or body parts and other infectious materials (Nyametso & Enchantee, 2023).

Globally, the hospital policies and practices and the type of care being provided is basic to determine the quantity of Bio-Medical Waste. The data available from developed countries indicate a range from 1-5 Kg/bed/day, with substantial inter country and inter specialty differences. Based on WHO report 2018, around 85% of the hospital wastes are actually non-hazardous, 10% are infective (hence, hazardous), and the remaining 5% are non-infectious but hazardous (chemical, pharmaceutical and radioactive) (Chowdhury & Islam, 2023).

Effective management of Biomedical Waste (BMW) is not only a legal necessity but also a social responsibility. Hospital waste management means the management of waste produced

by hospitals using techniques that will limit the spread of diseases. The process of waste management comprises key stages which are all very important and interrelated. These include segregation, collection, storage, handling, transportation, treatment and disposal (Aung, Luan, & Xu, 2019).

The most frequent issues with health care waste are inadequate financial and human resources for appropriate management; lack of waste management; ignorance of the health risks connected with it; and inadequate waste management procedures to protect the public's health environment (Rajan, Robin, & Vandananani, 2019).

In Egypt, there was lacking of hospital waste segregation, collection, storage, transportation & disposal awareness. Nursing staff members are immediately exposed to these concerns since they are in charge of managing waste disposal. (Sobh, 2018).

Providing effective and efficient treatment while also enhancing patient safety is the responsibility of nurses. Nurses can devote more time and resources to providing direct patient care when there is less waste in the provision of services, care, and treatment. In the healthcare industry, nurses play a critical role in cutting waste and motivating other professionals to work more productively and efficiently. through practicing a variety of roles. Nurses act as care provider, educator, manager, coordinator and researcher.

Significance of the study:-

Health care settings can be considered the most serious environmental problem because it can host potentially hazardous germs and increases the risk of infection transfer from healthcare facilities to healthcare staff, patients, and the general public. Biomedical waste is a particular challenge in most health-care facilities. Poor handling practices and inappropriate disposal of biomedical waste is an increasing health hazard that creating a health risk to municipal workers, the general public and the environment (Woromogo et al., 2020).

Effective waste management is essential for a cleaner and greener environment. Adequate knowledge regarding health hazard of biomedical waste, proper technique of handling and disposing the waste, and practicing safety measures can all go a long way in protecting the community from health hazards of biomedical waste (Deress, Jemal, Girma, & Adane, 2019). Hence, the present study aimed to assess current knowledge, attitude and practice of biomedical waste management among nurses in the rural health units.

The aim of this study was to:

Assess knowledge and practices of **nursing staff** regarding biomedical waste management at rural health units in Tanta city.

Research question

1. What is the level of knowledge and practices of **nursing staff** at rural health units regarding biomedical waste management?

Subjects and Method

Study design:

Descriptive study design was used in this study.

Study setting:

This study was conducted at 14 rural health units (50% of total rural health units of Tanta district) that were selected randomly using simple random technique from 28 rural health units that serve 30 villages affiliated to Tanta city.

Study subjects:

All the available nursing staff employed in the previously specified environments were covered by this investigation. (325) was their number.

Study tools

Tool I:

A structured questionnaire sheet that was developed and used by the researcher to collect the necessary data after revision of the recent literatures. It consisted of the following parts:

Part 1: Socio-demographic characteristics of the studied nursing staff.

This part covered the socio-demographic data about the studied nurses as: age, sex, marital status, years of experience, educational level, residence, previous training in the field of waste management and department where they work.

Part 2: Nurses' knowledge regarding biomedical waste and its management.

This part aimed to assess nurses' knowledge regarding biomedical waste and its management. It consisted of 29 questions that covered the following items: nurses' knowledge regarding policy of waste management, types of wastes, hazards of improper waste management, ways of waste management, steps of waste

management, places where biomedical wastes collected in addition to their source of information.

Scoring System:

The scoring system for the nurses' knowledge was as following: giving a score of (two) for complete correct answer, (one) for incomplete correct answer and (zero) for incorrect or wrong answer. The other questions that have only one right answer were scored as one point for the right answer and zero points for the wrong answer. These results were totaled and expressed as a percentage. The final score of knowledge ranged between 0-58 point. The nurses' level of knowledge was categorized as follow:-

- Low level of knowledge: less than 70% of the total knowledge score (<41points)
- Moderate level of knowledge : 70%: 80 % of the total score of knowledge (41-46 points)
- High level of knowledge: >80% of the total score of knowledge (>46points)

Part 3: Self-reported practices for nursing staff regarding biomedical waste management.

The researcher developed this part based on CDC (Centers for Disease Control and Prevention) guidelines policy for waste management ⁽²³⁾. It included 64 items related to the measures taken by the nurses regarding **biomedical waste management** such as follow universal precautions while dealing with **biomedical wastes (10 items)**, follow color coding segregation (separation) for **biomedical waste (9 items)**, follow assembly instructions printed on the waste containers (**11items**), disposal of sharp wastes (**14 items**), deal with liquid medical waste and safe disposal of it (**11 items**), deal with spills and safe disposal of it (**9 items**).

Scoring system: -

The scoring system for the nurses' reported practices was done as follow: For each item, the responses were scored as always done (two points), sometimes done (one point) and never done (zero point) except for the items (table VI:5- table VII:4,10 - table VIII:6,7,10,12,14 - table IX: 3,7,8,9 - table X: 7) that were scored two points. The total practice score ranged between (0-128) The responses of nurses was summed up and converted to percentage and the total practices score was categorized as follows:

- Satisfactory practices: \geq 85% (\geq 108points).
- Unsatisfactory: $<$ 85% ($<$ 108points).

Method:

1. Obtaining approvals

- The approval of the ethical committee of the faculty of nursing was obtained
- An official permission was obtained from the Dean of Faculty of Nursing, Tanta University to the directors of the selected rural health units affiliated to Tanta district, Al- Gharbiya Governorate.
- Permission to gather information from the chosen configurations and gain their co-operation was obtained from the directors of these units.

Ethical and legal considerations

Ethical and legal considerations were considered all over the study phases as the following:

- All nurses who were the subject of the study gave their informed permission after supplying a suitable justification for the study's objectives.
- Every participant was made aware of their ability to leave the research at any point while the data was being collected. The sample that was included in the study did not experience any injury or suffering due to its nature.

- Privacy and confidentiality were considered when collecting the data.

Developing the tools

- The study tool was developed and translated into Arabic language by the researcher based on examination of the literature and adjusted to the degree of understanding of all subjects.
- The developed tool was tested for its validity by a jury of five expert professors in the field of Community Health Nursing before conducting the study.

2. The pilot study.

- Thirty nurses, or around 10% of the sample as a whole, participated in a pilot research to assess the tool's clarity and usefulness in identifying potential roadblocks during data collection. As a result, the appropriate changes were made, such as paraphrasing some of the questions and removing ones that were asked again. The research sample did not contain this pilot sample.

-The Cronbach Alpha test was used to determine the study tool's reliability; the result was (0.83), indicating a very reliable instrument.

The actual study

- Collection of data was continued during a period about five months, starting at August 2022 and ending in December 2022.
- The researcher met the selected nurses two days per week in a suitable place (waiting areas) in rural health units.
- The structured questionnaire was distributed individually to each nurse to keep their privacy.
- The studied nurses were asked to fill the questionnaire in the waiting room according to their convenient time after the explanation of the purpose of the research. Then, the researcher checked them to a

certain that all the questionnaire sheet was filled.

- The time needed for each interview to complete the data collection sheet ranged from 20-30 minutes and the number of filled sheets per day was about 6-8 sheets.

3. Statistical analysis

The collected data were organized, tabulated and statistically analyzed using SPSS (statistical package for social studies) version 23.0 created by IBM computer company, Illinois, Chicago, USA).

The continuous data were all represented as mean and standard deviation (SD) and had a normal distribution. Numbers and percentages were used to convey categorical data. To compare variables using categorical data, the chi-square test was employed. To find a link between two quantitative variables in a single group, the linear correlation coefficient test was utilized.

Results:

Table (I) shows the distribution of the involved nurses according to their socio demographic data. It was clear that, the ages of the studied nurses ranged between 30-57 years with mean ages (43.22 ± 5.86) years. Less than half (45.5%) of them were of the age category 40 to less than 50 years and less than one quarter (23.1%) of them were less than 30 years of age. Most of the studied nurses (92.9%) were females and the majority (85.5%) of them were married.

As regard to the educational level, the table illustrates that, the majority (86.2%) of studied nurses had secondary nursing education. Also, the table shows that the majority (82.2%) of them lived in rural areas. Regarding to the studied nurses' years of experience, it ranged between 10-26 years, more than three

quarters (76.0%) of them had ≥ 20 years of experience.

Additionally, the table shows that, about one quarter (23.4%) of studied nurses worked in family planning clinic and only (3.4%) of them worked in surgery clinic. As regard to the studied nurses' training on the safe disposal of medical waste, it was obvious that less than two thirds (63.1%) of them attended training courses on the safe disposal of medical waste, slightly more than three quarters (75.1%) of them had attended 1-5 times training. However, less than two thirds of them (60%) had attended these training courses more than six months ago.

Table (II) demonstrates the distribution of the evolved nurses according to their knowledge regarding waste management. The table shows that, more than one third of the studied nurses gave right answers related to the waste collection according to the Hospital Waste Management Law, the site where the regular (semi-domestic) waste collected, the site where dirty dressing collected and Color of the plastic bag where infectious or biohazardous waste collected (34.8%, 35.4%, 38.5 and 36.3%) respectively. Meanwhile, more than two thirds of the studied nurses gave wrong answers related to definition of biomedical waste management and the main steps in management of waste (67.1% and 73.2%) respectively.

Table (III) shows the distribution of the studied nurses according to their knowledge regarding to waste disposal. The table shows that, the highest frequencies of the studied nurses didn't know or gave incorrect answers related to the instructions for segregation, benefits of segregation, the site where biomedical waste be segregated, instructions for the

final disposal of liquid medical waste, the time in which the lid of the waste container(s) be attached, the period can infectious waste be stored in the hospital in the summer, the time when safety boxes should be closed in order to prevent needle puncture, the way of getting rid of sharp waste, the instructions for separating radioactive waste and special instructions for cleaning up mercury spills (54.5%, 41.2%, 59.1%, 42.8%, 57.2%, 53.8%, 72.3%, 41.6%, 66.2% and 42.8%) respectively. On the other hand, more than one third of them gave incomplete correct answers related to the ways of waste disposal as benefits of segregation, the way of liquid waste disposal, the way of regular waste disposal, the way of hazardous medical waste disposal and special instructions for cleaning up mercury spills (34.8 % ,37.3%, 38.2% , 37.8% and 33.8%) respectively.

Figure (1) illustrates the distribution of the studied nurses according to the total level of their knowledge regarding biomedical waste management. It revealed that, more than two fifths (43.4%) of the studied nurses had low knowledge regarding biomedical waste management, while slightly more than one third (34.8%) of them had moderate level of knowledge and nearly about one fifth (21.8%) of them had high level of knowledge.

Table (IV) shows the distribution of the studied nurses according to their reported practices regarding following international precautions when caring for patients or dealing with biomedical waste. The table demonstrates that, slightly more than half (51.1%) of the studied nurses always wash their hands after removing the gloves after handling biomedical waste. Indeed, the highest frequencies of

the studied nurses did not follow the international precautions when dealing with patients or biomedical wastes as they never wear personal protection equipment while sorting waste, wear appropriate PPE when dealing with waste, wear rubber gloves during the medical service, wear rubber gloves when picking up litters that falls on the ground, wash their hands thoroughly after touching waste, even if they was wearing gloves, use heavy duty gloves when dealing with waste and wear all personal protective equipment's (gloves, mask, goggles, Macintosh)while dealing with liquid spills such as blood (52.3%, 44.9%, 47.1%, 49.8%, 37.8%, 39.1% and 40.9%) respectively.

Table (V) demonstrates the distribution of the studied nurses according to their reported practices regarding following the color-coding separation of waste. The table illustrates that, the color coding separation of waste weren't followed by the highest frequencies of the studied nurses except for putting regular waste in a black bin (58.5%) as they never follow the color coding separation of hazardous biomedical waste, put the waste in well-marked and colored containers, put hazardous waste like gauze in red bags, put the sharps in a red container, sort the medical waste at its collection point, separate sharp waste from hazardous waste, use foot-operated collection baskets when disposing of radioactive waste and dispose of the remains of human tissue in separate bags(47.1%, 52.7%, 58.5%, 53.6%, 56.3%, 50.1%, 62.5% and 46.5%) respectively.

Table (VI) demonstrates the studied nurses according to their reported practices regarding following the instructions printed on the waste containers. The table illustrates that, around half (49.5%,

46.8%, 47.1%, 50.1%, 47.4% and 46.8%) of the studied nurses never follow the instructions printed on the waste containers, keep garbage bags from getting full, expel the excess air from the bag without compressing the contents, collect waste and take it to a wastebasket for transportation, store radioactive waste inside the health facility or weigh the biomedical waste at the collection point in each unit (section) respectively. Furthermore, more than half (51.4%) of the studied nurses always reuse the plastic bag for waste collection.

Table (VII) demonstrates the studied nurses according to their reported practices regarding disposing sharp waste. It was clear that, the highest frequencies of the studied nurses reported incorrect practices regarding most of the items of sharp wastes disposal as they never keep sharps container on hand at each injection site, dispose of needles and syringes in sharps containers, put sharps in safe (prick proof) boxes, put sharps in a solid container, get rid of the tongue depressor in the safety box, dispose of the syringe with or without a tooth inside the safety box and dispose scalpels, glass, and sharp tools in a sharp waste container (59.1%, 49.2%, 48.3%, 40.6%, 50.8%, 44.9% and 59.7%) respectively and always collect syringes for disposal later and put fingers inside the sharps container (56.6% and 53.3%) respectively. On the other hand, the highest frequencies of the studied nurses reported correct practices regarding disposing of sharp waste as they never dispose needles, syringes and sharp instruments in red bags, dispose needles, syringes and sharp instruments in black bags, Re-cover the syringe before disposing it in the safety box and dispose

sharp instruments in red bags (51.4%, 47.7%, 47.7% and 59.1%) respectively.

Table (VIII) illustrates the distribution of the studied nurses according to their reported practices regarding dealing with liquid medical waste and safe disposal of it. The table illustrates that, more than one quarter (29.3%, 26.8%, 25.8%, 25.5%, 26.8% and 28.3%) of the studied nurses reported correct practices regarding dealing with liquid medical waste as they always wear latex gloves when handling liquid medical waste, wear heavy-duty footwear when handling liquid medical waste, pour water into the closed drainage area (bathroom) to remove the remaining liquid waste, transport lab samples inside closed boxes, clean the containers that contained the liquid waste with running water and soap, then apply chlorine 1000 ppm for ten minutes and dispose of liquid waste in the sewage system respectively. Furthermore, around half (44.3%, 51.4%, 50.5% and 47.4%) of the studied nurses reported that they never dispose of liquid medical waste in a drain (bathroom) used by patients, close windows after cleaning up mercury spills, never get rid of blood waste in bags and never dispose of liquid waste in bags respectively. However, more than two fifths (44.9%, 43.7%, 45.5%, 43.1%, 40.6% and 47.4%) of the studied nurses reported improper practice regarding dealing with liquid medical wastes as they never wear latex gloves when handling liquid medical waste, wear heavy-duty footwear when handling liquid medical waste, transport lab samples inside closed boxes, clean the containers that contained the liquid waste with running water and soap, then apply chlorine 1000 ppm for ten minutes, dispose of liquid waste in the sewage system and dispose of liquid waste in the

laboratory in the spill basin or sewage respectively.

Table (IX) demonstrates the distribution of the studied nurses according to their reported practices regarding dealing with spills and safe disposal of it. The table illustrates that, around one third (29.2%, 28.9% and 34.8%) of the studied nurses always deal with a large bloody spill with a chlorine concentration of 5000 parts per million, provide all supplies and all personal protective equipment inside the spill box and wear personal protectors while dealing with spills respectively. On the other hand, it was obvious that less than half (41.5%, 43.7%, 44.6%, 42.1% and 45.2%) of the studied nurses never put a danger sign in the event of a bloody spillage before dealing with it, never leave the chlorine on the spill site for ten minutes, never collect liquid spills from outside to inside (from the least polluted

place to the most polluted place), never place the spill box outside the clinic and never collect broken glass in case of a spill associated with breaking a glass container before dealing with the spill respectively.

Figure (2) shows the studied nurses according to the total score of their reported practice regarding biomedical waste management. It was (39.4%) of studied nurses had satisfactory practice regarding biomedical waste management compared to more than half of them (60.6%) who had unsatisfactory practice.

Table (X) shows the correlation between total knowledge score and total reported practice score of the studied nurses regarding biomedical waste management. There was highly statistically significant positive correlation between total knowledge score and total reported practice score (p -value $<0.001^*$).

Table (I): Distribution of the studied nurses according to their socio demographic data.

Socio-demographic characteristics of nurses	Studied nurses. N (325)	
	N	%
Age		
30- <40	75	23.1
40- <50	148	45.5
50 or more	102	31.4
Range	30-57	
(Mean±SD)	(43.22±5.86)	
Sex		
Male	23	7.1
Female	302	92.9
Marital status		
Single	11	3.4
Divorced	12	3.7
Widow-Widower	24	7.4
Married	278	85.5
Place of residence		
Urban	58	17.8
Rural	267	82.2
Educational level		
Nursing Diploma	280	86.2
Nursing Technical Institute	26	8.0
Bachelor or Postgraduate	19	5.8
Years of experience		
10- <20	78	24.0
20 or more	247	76.0
Range	10-26	
(Mean±SD)	(17.5±4.14)	
Attending training courses on the safe disposal of medical waste		
Yes	205	63.1
No	120	36.9

Table (II): Distribution of the studied nurses according to their knowledge regarding waste management.

Variables	Studied nurses n = 325			
	Right		Wrong	
	N	%	N	%
Definition of biomedical waste management	107	32.9	218	67.1
Waste collection according to the Hospital Waste Management Law	113	34.8	212	65.2
The main steps in management of waste	87	26.8	238	73.2
The site where the regular (semi-domestic) waste collected	115	35.4	210	64.6
The site where dirty dressing collected	125	38.5	200	61.5
Color of the plastic bag where infectious or biohazardous waste collected	118	36.3	207	63.7

Table (III): Distribution of the studied nurses according to their knowledge regarding waste disposal.

Knowledge related segregation of waste	N	%
The instructions for segregation		
Complete correct	42	12.9
Incomplete correct	106	32.6
Incorrect	177	54.5
Benefits of segregation		
Complete correct	78	24.0
Incomplete correct	113	34.8
Incorrect	134	41.2
The site where biomedical waste be segregated		
Right	133	40.9
Wrong	192	59.1
Instructions for the final disposal of liquid medical waste		
Complete correct	83	25.5
Incomplete correct	103	31.7
Incorrect	139	42.8
The time in which the lid of the waste container(s) be attached		
Right	139	42.8
Wrong	186	57.2
The period can infectious waste be stored in the hospital in the summer		
Right	150	46.2
Wrong	175	53.8
The time when safety boxes should be closed In order to prevent needle punctures		

Right	90	27.7
Wrong	235	72.3
Knowledge related ways of waste disposal		
The way of liquid waste disposal		
Complete correct	96	29.5
Incomplete correct	121	37.3
Incorrect	108	33.2
The way of regular waste disposal		
Complete correct	84	25.8
Incomplete correct	124	38.2
Incorrect	117	36.0
The way of hazardous medical waste disposal		
Complete correct	80	24.6
Incomplete correct	123	37.8
Incorrect	122	37.6
The way of getting rid of sharp waste		
Complete correct	95	29.2
Incomplete correct	95	29.2
Incorrect	135	41.6
The instructions for separating radioactive waste		
Right	110	33.8
Wrong	215	66.2
Special instructions for cleaning up mercury spills		
Complete correct	76	23.4
Incomplete correct	110	33.8
Incorrect	139	42.8

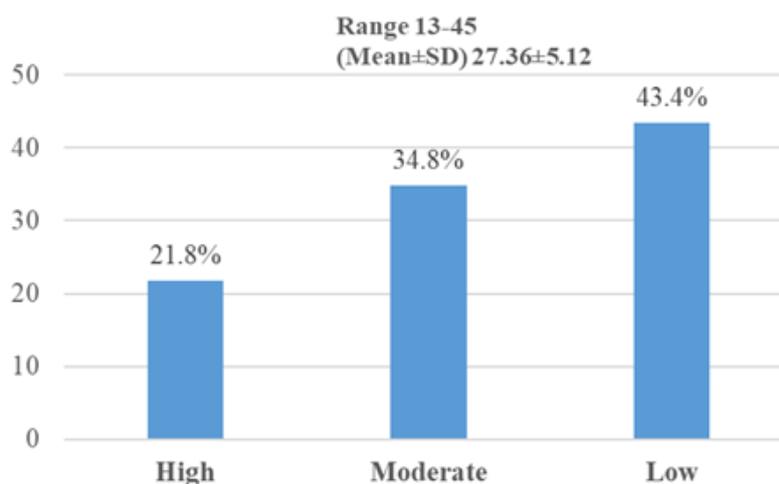


Figure (1): Distribution of the studied nurses according to the total level of their knowledge regarding biomedical waste management.

Table (IV): Distribution of the studied nurses according to their reported practices regarding following international precautions when caring for patients or dealing with biomedical waste.

Variables	Studied nurses (N=325)					
	Always		Sometimes		Never	
	N	%	N	%	N	%
Wear personal protective equipment while sorting waste	57	17.5	98	30.2	170	52.3
Wear appropriate personal protective equipment (PPE) when handling waste	74	22.8	105	32.3	146	44.9
Wear rubber gloves during the medical service	76	23.4	96	29.5	153	47.1
Wear rubber gloves when picking up litters that falls on the ground	85	26.2	78	24.0	162	49.8
Wash hands thoroughly after touching waste, even if was wearing gloves	90	27.7	112	34.5	123	37.8
Use heavy duty gloves when dealing with waste	84	25.8	114	35.1	127	39.1
Wear all personal protective equipment's (gloves, mask, goggles, Macintosh) while dealing with liquid spills such as blood	86	26.5	106	32.6	133	40.9
Wear heavy duty gloves when transporting waste	129	39.7	121	37.2	75	23.1
Wear a mask when dealing with a mercury spill	160	49.2	87	26.8	78	24.0
Wash hands after removing the gloves after handling biomedical waste	166	51.1	92	28.3	67	20.6

Table (V): Distribution of the studied nurses according to their reported practices regarding following the color-coding separation of waste.

Variables	Studied nurses (N=325)					
	Always		Sometimes		Never	
	N	%	N	%	N	%
Follow the color-coding separation of hazardous biomedical waste	67	20.6	105	32.3	153	47.1
Put the waste in well-marked and colored containers	57	17.5	97	29.8	171	52.7
Put hazardous waste like gauze in red bags	39	12	96	29.5	190	58.5
Put regular waste in a black bin	190	58.5	90	27.7	45	13.8
Put the sharps in a red container	57	17.5	94	28.9	174	53.6
Sort the medical waste at its collection point	56	17.2	86	26.5	183	56.3
Separate sharp waste from hazardous waste	74	22.8	88	27.1	163	50.1
Use foot-operated collection baskets when disposing of radioactive waste	43	13.2	79	24.3	203	62.5
Dispose of the remains of human tissue in separate bags	70	21.5	104	32	151	46.5

Table (VI): Distribution of the studied nurses according to their reported practices regarding following the instructions printed on the waste containers.

Variables	Studied nurses (N=325)					
	Always		Sometimes		Never	
	N	%	N	%	N	%
Follow the instructions printed on the waste container	74	22.8	90	27.7	161	49.5
Close the lid of the sharps container when it is three-quarters full	73	22.5	112	34.4	140	43.1
Fill the safety box only once and then dispose of it	84	25.8	105	32.3	136	41.9
Black bags can be used more than once if they are not full	82	25.3	97	29.8	146	44.9
Keep garbage bags from getting full	68	20.9	105	32.3	152	46.8
At the point (place) of waste generation, excess air is expelled from the bag without compressing the contents prior to closure using a bag tie	69	21.2	103	31.7	153	47.1

Table (VII): Distribution of the studied nurses according to their reported practices regarding disposing of sharp waste

Variables	Studied nurses (N=325)					
	Always		Sometimes		Never	
	N	%	N	%	N	%
Keep a sharps container on hand at each injection site	57	17.5	76	23.4	192	59.1
Collect syringes for disposal later	184	56.6	87	26.8	54	16.6
Put fingers inside the sharps container	173	53.3	84	25.8	68	20.9
Dispose needles and syringes in sharps container	69	21.2	96	29.6	160	49.2
Put sharps in safe (prick proof) boxes and never in waste bags	63	19.4	105	32.3	157	48.3
Put sharps in a solid container	75	23.1	118	36.3	132	40.6
Dispose needles, syringes and sharp instruments in red bags	87	26.8	71	21.8	167	51.4
Dispose the used needle and sharps immediately	84	25.8	108	33.3	133	40.9
Get rid of the tongue depressor in the safety box	76	23.4	84	25.8	165	50.8
Dispose needles, syringes and sharp instruments in black bags	87	26.8	83	25.5	155	47.7
Dispose of the syringe with or without a tooth inside the safety box	84	25.8	95	29.3	146	44.9
Re-cover the syringe before disposing it in the safety box	76	23.4	94	28.9	155	47.7
Dispose scalpels, glass, and sharp tools in a sharp waste container	38	11.7	93	28.6	194	59.7
Dispose sharp instruments in red bags	37	11.4	96	29.5	192	59.1

Table (VIII): Distribution of the studied nurses according to their reported practices regarding dealing with liquid medical waste and safe disposal of it.

Variables	Studied nurses (N=325)					
	Always		Sometimes		Never	
	N	%	N	%	N	%
Wear latex gloves when handling liquid medical waste	95	29.3	84	25.8	146	44.9
Wear heavy-duty footwear when handling liquid medical waste	87	26.8	96	29.5	142	43.7
Dispose of liquid medical waste in a drain (bathroom) used by patients	86	26.5	95	29.2	144	44.3
Pour water into the closed drainage area (bathroom) to remove the remaining liquid waste	84	25.8	116	35.7	125	38.5
Transport lab samples inside closed boxes	83	25.6	94	28.9	148	45.5
Clean the containers that contained the liquid waste with running water and soap, then apply chlorine 1000 ppm for ten minutes	87	26.8	98	30.1	140	43.1
Close windows after cleaning up mercury spills	73	22.5	85	26.1	167	51.4
Dispose of liquid waste in bags	95	29.2	75	23.1	155	47.7
Get rid of blood waste in bags	68	20.9	93	28.6	164	50.5
Dispose of liquid waste in the spin basin or the sewage system	92	28.3	101	31.1	132	40.6
Dispose of liquid waste in the laboratory in the spill basin or sewage	76	23.4	95	29.2	154	47.4

Table (IX): Distribution of the studied nurses according to their reported practices regarding dealing with spills and safe disposal of it.

Variable	Studied nurses (N=325)					
	Always		Sometimes		Never	
	N	%	N	%	N	%
Put a danger sign in the event of a bloody spillage before dealing with it	78	24	112	34.5	135	41.5
Deal with small blood spills with chlorine concentration of 1000 parts per million	84	25.8	115	35.4	126	38.8
Deal with a large bloody spill with a chlorine concentration of 5000 parts per million	95	29.2	113	34.8	117	36
Leave the chlorine on the spill site for ten minutes (contact time)	75	23.1	108	33.2	142	43.7
Collect liquid spills from outside to inside (from the least polluted place to the most polluted place)	76	23.4	104	32	145	44.6
Provide all supplies (chlorine, single-use towel, shovel) and all personal protective equipment (latex gloves, Macintosh, eye protection, surgical mask) inside the spill box	94	28.9	113	34.8	118	36.3
Place the spill box outside the clinic	73	22.5	115	35.4	137	42.1
Collect broken glass in case of a spill associated with breaking a glass container before dealing with the spill	75	23.1	103	31.7	147	45.2
Wear personal protectors while dealing with spills	113	34.8	126	38.8	86	26.4

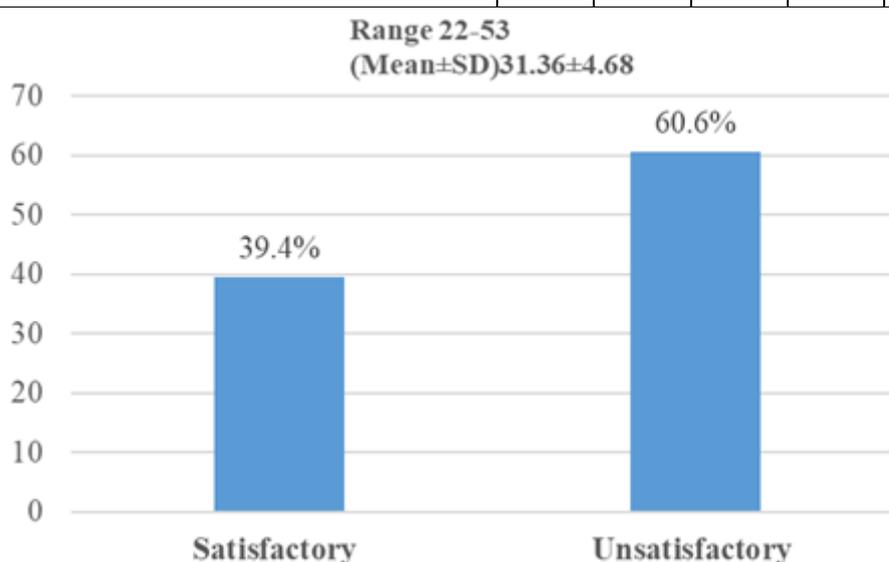
**Figure (2): Distribution of the studied nurses according to the total score of their reported practice regarding biomedical waste management**

Table (X): Correlation between total knowledge score and total reported practice score of the studied nurses regarding biomedical waste management.

	Total knowledge	
	R	P
Total practice	0.764	<0.001

**** Highly significant at 0.001**

Discussion

The present study showed less than The majority of the nurses under study were married, and half of them fell into the age group of 40 to less than 50 years old, with mean ages of 43.22 ± 5.86 years (Table I). These results are consistent with (Sobh, 2018) In a study titled "Knowledge and practice of staff nurses related to health care waste management," the researchers found that most of the nurses were female and that slightly less than two thirds of the nurses were in the age group over 30, with a mean of 34.3 ± 7.8 years. Also this result confirmed by (Abdallah et al.,2018) who studied "Staff Nurses' Knowledge and Commitment toward Hospital Waste Management" and reported that, the mean age 38.0 years old and the great majority were females.

As regard to the educational level, the present study showed that, the majority of studied nurses had secondary nursing education and more than three quarters of studied nurses had 20 years or more of experience, less than two thirds of them attended the training. In agreement with these results, (Sobh, 2018) who reported that the most of the studied nurses possessed training in secondary nursing. Two thirds of the nurses attended waste management

training programs, and over half of them had more than ten years of experience. Moreover, this result come in accordance with (Khashaba et al.,2023) who studied "Effect of a waste management intervention program on knowledge, attitude, and practice (KAP) of nurses " and reported that more than half of the studied nurses attend previous training courses about biomedical waste management.

Concerning the studied nurses' knowledge regarding waste management, the present study showed that, more than two thirds of the studied nurses gave wrong answers related to definition of biomedical waste management and the main steps in management of waste (Table II). This results may due to low level of knowledge is mainly attributed to poor training facilities and also to relatively low educational level of the nursing staff. Training of both the technical staff and the nontechnical staff is critical for the proper and appropriate management of biomedical waste.

These findings are similar to those of (Soyam et al.,2017) who carried the research on the management of biomedical waste among Delhi's healthcare personnel and reported that,

less than three quarter of the studied nurses had poor knowledge regarding the process of biomedical waste management. Also these results come in accordance with **(Al Emad,2011)** who conducted a study The study titled "Assessment of Medical Waste Management in Yemen's Main Hospitals" revealed that a majority of the nurses under investigation had little understanding of medical waste among waste staff.

While these findings were contradicted with **(Hassan et al.,2020)** who studied "Knowledge, Attitude and Practices regarding Biomedical Waste Management among Health Care Professionals of Private Sector Hospitals in Pakistan" and reported that, the majority of the respondents had good knowledge regarding biomedical waste management. Also this result comes in consistent with **(Dalui et al.,2021)** who studied "Assessment of Knowledge, Attitude, and Practice about Biomedical Waste Management among Healthcare Workers during COVID-19 Pandemic in a Health District of West Bengal" and reported that, the most of the nurses had satisfactory knowledge about biomedical waste management process.

The present study showed that, the highest frequencies of the studied nurses didn't know or gave incorrect answers related to the instructions for segregation, benefits of segregation, the site where biomedical waste be segregated, instructions for the final disposal of liquid medical waste, the time in which the lid of the waste container(s) be attached, the period can infectious waste be stored in the hospital

in the summer, the time when safety boxes should be closed in order to prevent needle puncture, the way of getting rid of sharp waste, the instructions for separating radioactive waste and special instructions for cleaning up mercury spills Table (III). This might be the case since, even in Egypt, medical practitioners are still failing to properly manage and dispose of hospital waste, even in spite of legislation mandating such actions. These results come in accordance with **(Elnour et al.,2015)** who studied "Impacts of health education on hospital staff knowledge and practice regarding healthcare waste management at main hospitals in White Nile State, Sudan" and reported that half of the intervention study group had fair knowledge regarding segregation and disposal of biomedical waste.

While these results were not in agreement with **(Sarkees, 2018)** who studied "assessment of nurses' knowledge about healthcare waste management in duhok city" and reported that more than two thirds of nurses show high level of knowledge toward management of healthcare waste. Also, these results come inconsistent with **(Letho et al.,2021)** who studied "Awareness and practice of medical waste management among healthcare providers in National Referral Hospital" and reported that less than three quarter of health care providers are aware of medical waste management and the majority were aware about the importance of using proper personal protective equipment.

Concerning the total level of their knowledge regarding biomedical waste management, the results of this survey indicated that almost two fifths of the nurses who were examined knew very little about biomedical waste management, while slightly more than one third of them had moderate knowledge and less than quarter of them had high level of knowledge (Figure I). This may be the majority of studied nurses had low educational level and may be due to a lacking curriculum with regard to HCW management in secondary school, lack of training, and/or unavailability of HCW management handouts and tools in the rural unit.

These finding is matched with a research conducted by **(Tiwari et al.,2021)** whose Research Concerned Biomedical Waste: Knowledge, Attitude, and Practices Management among Nursing Students at Yatharth Nursing College and Paramedical Institute, Chandauli in India" and reported that majority of The majority of participants knew very little about managing biological waste. In addition, these results come in the in agreement with **(Akkajit et al., 2020)** who conducted a study about " Assessment of Knowledge, Attitude, and Practice in respect of Medical Waste Management among Healthcare Workers in Clinics in Tailand " and found that, the most of the studied participants had lack of knowledge about waste segregation and waste collection and lack of risk awareness.

Moreover, these results come inconsistent with **(Jalal et al.,2021)** who studied "Assessment of knowledge, practice and attitude about biomedical

waste management among healthcare professionals during COVID-19 crises in Saudi Arabia, King Faisal University, Al-Ahsa Healthcare" and reported that, majority of the healthcare workers had sufficient knowledge regarding biomedical waste management. Also this result disagree with **(Abdallah et al., 2018)** who reported that the majority of nurses had satisfactory knowledge of biomedical waste management.

Indeed, the highest frequencies of the studied nurses did not follow the international precautions when dealing with patients or biomedical wastes as they never wear personal protection equipment while sorting waste, wear appropriate PPE when dealing with waste, wear rubber gloves during the medical service, wear rubber gloves when picking up litter that falls on the ground, wash their hands thoroughly after touching waste, even if was wearing gloves, use heavy duty gloves when dealing with waste and wear all personal protective equipment's (gloves, mask, goggles, Macintosh) while dealing with liquid spills such as blood (Table IV).These results might be influenced by the absence of an enabling environment in the health institution such as lack of constant running water or shortage of personal protective equipment which intern can lead to poor practices with standard precautions.

These findings come in the line with **(Letho et al., 2021)** who studied " Practice of medical waste management among healthcare providers in National Referral Hospital" and reported that the most of the studied sample had poor practices regarding international

precautions when caring for patients or dealing with biomedical waste. While these findings come inconsistent with **(Asmr et al., 2019)** who assessed Knowledge and practices of standard precaution against blood borne pathogens among doctors and nurses at adult emergency room in Addis Ababa, Ethiopia" and mentioned that the majority of nurses have good practice regarding compliance to hand washing and wearing personal protective equipment. The same was reported by **(Dalui et al., 2021)** who illustrated that, most of the nurses always followed the guidelines while dealing with the biomedical wastes.

The present study demonstrated that, the color coding separation of waste weren't followed by the highest frequencies of the studied nurses except for putting regular waste in a black bin as they never follow the color coding separation of hazardous biomedical waste, put the waste in well-marked and colored containers, put hazardous waste like gauze in red bags and put the sharps in a red container. More than half of them never sort the medical waste at its collection point, never separate sharp waste from hazardous waste, never use foot-operated collection baskets when disposing of radioactive waste (Table V). These results might be due to inadequate special containers for disposal, lack of proper training or lack of guidelines and legislations regarding waste segregation.

These result was supported by **(Dey et al., 2022)** who assessed knowledge, attitude and practice about biomedical waste management among

health care workers in primary health care facilities in a District of West Bengal and reported that, the most of the studied nurses had poor practices regarding disposal of BMW maintaining color coding. The same was reported by **(Abou Hashish et al., 2020)** who conduct a study about " Knowledge, attitude and practice of undergraduate and intern Saudi nursing students regarding biomedical waste management and influencing factors" and demonstrated that, the most of the studied sample didn't follow the color coding separation of hazardous biomedical waste and throw the sharp object in the a red container.

While these result come in disagreement with **(Joseph, 2022)** who assessed health workers' knowledge, attitudes and practices regarding biomedical waste disposal during the covid-19 pandemic In Jhansi city and clarified that, the majority of nurses followed the color-coding of biomedical waste management and half of them followed policies in separating the wastes according to hazard. The same was reported by **(DhirendraSoni et al., 2023)** who assessed perception and practice of hospital waste management among medical and nursing personnel" and reported that, most of the nurses discard safely the used needles and follow segregation of biomedical waste management and never throw the general waste in bins for hospital waste management which is shown.

Regarding the studied nurses reported practices regarding following the instructions printed on the waste containers, the present study showed

that, less than half of the studied nurses never follow the instructions printed on the waste containers, close the lid of the sharps container when it is three-quarters full, fill the safety box only once and then dispose of it, use black bags more than once if they are not full, keep garbage bags from getting full, compress the contents prior to closure using to expel air, close the garbage bag when it is 2/3 to 3/4 full, collect waste and take it to a wastebasket for transportation, store radioactive waste inside the health facility and weigh the biomedical waste at the collection point in each unit (section), more than half of them always reuse the plastic bag for waste collection (Table VI). These results might be due to Poor HCW management is caused by a number of factors, including the lack of rules and regulations pertaining to waste collection and on-site transportation to a temporary storage location, improper waste treatment, disposing of MW alongside municipal garbage, inadequate staff training, inadequate personal protective equipment (PPE), and ignorance of how to use such equipment.

These outcomes are consistent with (Akkajit et al., 2020) who reported that, the most of the studied sample had unsatisfactory practices regarding following the instructions printed on the waste containers, the use of sharps container, safety box dispose, policy of collecting and disposing biomedical waste. Also these results confirmed by (Joseph, 2022) who reported that less than half of the studied nurses not following the instructions printed on the waste containers such as safety box, plastic bag, storing of biomedical waste.

While these results disagree with (Ali, 2022) who studied "assessment of knowledge, attitude and practice of biomedical waste management among health care personnel at El-Mak Nimer University Hospital 2021" and reported that more than half of the studied nurses had satisfactory practices regarding disposal of sharps in puncture proof container.

Concerning reported practices regarding disposing of sharp waste, according to the present study, almost half of the nurses that were studied never keeps a sharps container on hand at each injection site, never dispose of needles, never dispose syringes and sharp instruments in red bags, never get rid of the tongue depressor in the safety box, never dispose of scalpels, glass, and sharp tools in a sharp waste container and never dispose of sharp instruments in red bags (Table VII). This result might be due to the majority of the studied nurses had low educational level that, may affect the nurses performance regarding waste management.

These results come in agreement with (Mugabi et al., 2018) who studied "the knowledge, attitudes, and practices of healthcare workers regarding medical waste management at a tertiary hospital in Botswana" and reported that, less than half of the studied nurses had poor practices regarding disposing of syringes, needles and patients equipment's. While these results disagree with (Alanazi et al., 2023) who studied " knowledge, attitude and practice of nurses toward covid-19 related medical waste management" and found that the most of studied nurses had

good practice regarding the medical waste disposal

Regarding the studied nurses' reported practices while dealing with liquid medical waste and safe disposal of it, according to the results of the current study, almost two fifths of the nurses who were examined acknowledged inappropriate behavior with dealing with liquid medical wastes as they never wear latex gloves when handling liquid medical waste, wear heavy-duty footwear when handling liquid medical waste, dispose of liquid medical waste in a drain (bathroom) used by patients, transport lab samples inside closed boxes, clean the containers that contained the liquid waste with running water and soap, then apply chlorine 1000 ppm for ten minutes, dispose of liquid waste in the sewage system and dispose of liquid waste in the laboratory in the spill basin or sewage (Table VIII).

This results was confirmed by (Agamuthu et al., 2021) who studied "Clinical waste management under COVID-19 scenario in Malaysia" and reported that there is lack of proper handling and clinical waste management, blood or body fluid, excretions, mixed waste, laboratory waste, material or equipment contaminated with the virus, masks or disposable gloves, and PPE that is used. While these results come inconsistent with (Dlamini, 2021) who studied "Knowledge, attitudes and practices of healthcare workers towards the care of Tuberculosis patients in primary healthcare facilities of UMkhanyakude district" It revealed that almost half of the nurses in the study had

follow safety precaution while dealing with body fluid.

In relation to the nurses reported practices regarding dealing with spills and safe disposal, the present study demonstrated that, less than half of the studied nurses never collect liquid spills from outside to inside (from the most polluted place to the least polluted place), never place the spill box outside the clinic and never collect broken glass in case of a spill associated with breaking a glass container before dealing with the spill respectively (Table IX). This results come in accordance with (Ibrahim et al., 2022) who studied "nurses' performance regarding infection control precautions in primary health care centers" and reported that more than half of the studied nurses were incompetent regarding safe disposal of waste and dealing with textiles and personal protective equipment and respiratory precautions. While these results come inconsistent with (Zayed et al., 2019) who studied Knowledge, attitudes, and behaviors about the safe handling of cytotoxic medications among Tanta University hospitals' oncology nurses and reported that, the majority of the studied sample manage accidents as spills based on standard protocols, follow standard guidelines for handling of medical wastes and always wear PPE during transport and storage.

Concerning the studied nurses' total reported practice regarding biomedical waste management the present study showed that, slightly less than two fifths of studied nurses had satisfactory practice regarding biomedical waste management compared

to more than half of them who had unsatisfactory practice (Figure 3). This result come in the same line with (Tiwari et al., 2021) who reported that less than three quarter of the studied sample had poor practices regarding biomedical waste management. Also this result was supported by (Elsayed et al., 2020) who studied "assessment of medical waste generation rate at Zagazig University Hospitals and awareness and practices of nurses regarding medical waste management" and reported that practice of nurses regarding biomedical waste management are relatively unsatisfactory. While these results contraindicated with (Abdallah et al., 2018) who reported that, the most of staff nurses had high commitment to the biomedical waste management steps.

Concerning the There was a highly statistically significant positive link between the examined nurses' total reported practice score and their total knowledge score regarding biomedical waste management, according to the current study. (p-value <0.001*) (Table X). This result might be due to, the nurses' adequate knowledge regarding health hazard of biomedical waste, proper technique of handling and disposing the waste will have a positive impact on practicing safety measures while dealing with biomedical waste

This finding was corroborated by (Thirunavukkarasu et al., 2022) who studied " Knowledge, attitude and practice towards bio-medical waste management among healthcare workers: a northern Saudi study" and reported that, there were positive correlation of knowledge with the participants practices

regarding waste management. More over this result confirmed by (Farouk et al., 2022) who reported that, Between the nurses' stated habits and their knowledge of managing health care waste, there found a positive linear association that was highly statistically significant. In addition this finding was supported by (Woromogo et al., 2020) who assess knowledge, attitudes, and practices of healthcare workers regarding biomedical waste management at Biyem-Assi District Hospital Yaounde and reported that there were statistical significance relationship between the studied sample awareness of the processes and procedures used in the biomedical waste management process.

Conclusion: More than two fifths of the studied nurses had low knowledge regarding biomedical waste management and more than half of them had unsatisfactory reported practice. There was highly statistically significant positive correlation between total knowledge score and total reported practice score of the studied nurses regarding biomedical waste management. **Recommendation:** : It is essential to identify nurses training needs regarding safe waste management policies and guidelines through ongoing evaluation of nurses' proficiency with and understanding of waste management in healthcare settings.

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