Assessment of Medical Waste Generation Rate at Zagazig University Hospitals and Awareness and Practices of Nurses Regarding Medical Waste Management

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ABSTRACT

Background: The amount and management of medical wastes are issues of growing concern since these wastes are a major source of contamination and pollution and their proper management must be known by all nurses. Objectives of the study: To quantify the medical waste generation rate of clinical departments of zagazig university hospitals (ZUH) and to assess and compare the awareness and practice of nurses in these departments regarding medical waste management. Subjects and methods: A cross-sectional study was conducted over a period of 3 months in 2013 in all departments and units of (ZUH) which were classified into 4 main strata according to the similarity of the work conditions. A sample of 181 nurses were selected by stratified random sampling technique. The study tools composed of 1) Format for quantities of wastes of different departments to compare them and calculate the amount of waste per bed per day.2) A pre constructed questionnaire which contains demographic data, self-administered Knowledge Questionnaire Sheet and questions related to attitude of nurses about medical waste. 3) Checklist for evaluation of practice of nurses in waste management. Results: The mean values of medical waste amount per day were statistically higher among" the surgical departments & anesthesia"(45.0±15.0) versus other departments groups "Internal Medicine Departments and Pediatrics ", " Outpatient Clinics and Blood Bank" and " Causality, Intensive Care, and Emergency" with values (20.0±3.5, 32.0±4.0 and 30.0±3.2) respectively. The average quantity of the total Zagazig hospitals of hazardous medical waste per bed per day is 1.5 Kg which is comparable to national and other developing countries values. No significant difference between the four strata of departments regarding scores of knowledge, attitude and practice. The overall percentages of nurses with low & average scores of knowledge were "(31.5%, 22.6% respectively while those with high score were 45.9 %. Scores of attitude and practice showed percentages of 17.7%, 40.3% and 42.0 % of those with low, average and high scores respectively. Factors associated with having unsatisfactory scores (low& average) of knowledge, attitude and practice were low socioeconomic class, female gender and low education level with highly significant differences. Conclusion: The hazardous waste generation rate per bed per day in Zagazig University Hospitals is average but the awareness and practice of nurses are relatively unsatisfactory and greatly affected by their socio-economic level, sex and education. So, elevation of socio economic class and education level of nurses especially female together with training programs are important to improve awareness and practice The highest priority to should be given to "surgical departments and anesthesia" group where the largest quantity of waste is generated.

Keywords: Biomedical waste, waste management, knowledge, awareness and waste generation rate.

Introduction

Medical waste is defined as waste generated during the diagnosis, testing, treatment, research or production of biological products for humans or animals. Medical waste includes syringes, live vaccines, laboratory samples, body parts, bodily fluids and waste, sharp needles, cultures and lancets (Pasupathi *et al*., 2011).

Healthcare waste management includes all activities involved in waste generation, segregation, transportation, storage, treatment and final disposal of all types of waste generated in the healthcare facilities, stages of which require special attention (Manyele and Lyasenga, 2010).

Approximately 75-90% of the health care wastes are non-hazardous and as harmless as any other municipal waste. The remaining 10-25% are hazardous and can be injurious to humans or animals and deleterious to environment. It is important to realize that if both these types are mixed together then the whole waste becomes harmful (Pasupathi *et al*., 2011)

Medical wastes are considered as a hazardous waste because they contain toxic materials, infectious and /or radioactive wastes ,so, they can harm millions of patients, health care workers, and visitors (Labib *et al*., 2005).

Waste items from healthcare settings were categorized into six types according to the Egyptian environmental protection law namely: (1) sharps (needles, glass vials or scalpel blades); (2) pathological anatomical body parts, microbiology cultures and blood samples; (3) infectious wastes (items contaminated with body fluids and discharges such as dressing, catheters and I.V. lines); (4) chemical and radioactive wastes

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(mercury containing instruments and PVC plastics); (5) pressurized containers; and pharmaceutical waste (Soliman and Ahmed, 2007) .

The health risks associated with hazardous medical waste can be divided into five categories; risk of trauma, risk of infection, chemical risk, risk of fire or explosion and risk of radioactivity. The risk of environmental pollution and contamination must be added to these categories (ICRC, 2011).

Segregation is a very important stage in the waste management process. It refers to separation of waste into designated categories, this enables those who handle the containers outside the hospital wards to identify and treat them appropriately. Also, it reduces medical waste & this also reduces the health impacts on the general public and the budget required for health care waste disposal (El-Sayed *et al.*, 2012).

Treatment processes for medical wastes comprise autoclaving, microwaving, chemical disinfection, irradiation, plasma system and incineration (Labib *et al.*, 2005).

The quantity of waste produced in a hospital depends on the level of national income and the type of facility concerned. A university hospital in a high-income country can produce up to 10 kg of waste per bed per day, all categories combined (ICRC, 2011).

In the majority of low-income countries, health-care waste is usually not separated into hazardous or nonhazardous waste. In these countries, the total health-care waste per person per day is anywhere from 0.5 to 3kg (WHO, 2007).

In Egypt, a middle income country, some reports estimate the waste size by 1 kg/bed/day on average and there are 123000 beds in governmental and private hospital in Egypt, so, at least, 123 tons of hospital waste is generated per day (Ministry of Health and Population, 2008) **.**

Egyptian legislation: Law 9/2009 amended Law 4/1994 for the protection of the environment and regulates collection, treatment and disposal of hazardous waste (Articles 29 – 33). Moreover, Article 37 (2) of this law prohibits open burning of garbage and solid waste and prohibits placement, sorting, and treatment of wastes in areas other than those specified out of residential, industrial and agricultural areas and waterway (RSWEIE, 2010).

Many nurses especially at the beginning of their career are not aware of the proper management of the medical wastes. Therefore, they may not only harm themselves but also share in dissemination of these hazardous wastes and they are occupational group vulnerable to catastrophic diseases if unaware. Therefore, the current status of nurses' awareness regarding bio-medical waste management will help the authorities to develop the strategy for improving the situation in future.

Objectives:

1) To quantify the medical waste generation rate in zagazig university hospitals.
2) To asses and compare awareness and practice of medical waste management among nurses of different medical departments of zagazig university hospitals..
3) To study the influence of some factors on awareness and practice of medical waste management among nurses.

Subjects and methods:

Study design, setting & time:

A cross-sectional study was conducted on nurses working at Zagazig university hospitals over the period of 3 months (from October 1st to December 31st 2013).

The Sample size was calculated using Epi info version 6.04 (Dean *et al.*, 2001); According to the statistical annual of Zagazig University Hospitals, the total number of registered nurses at the year 2013 was 2500 nurse but the net working ones were 2400. With expected frequency of nurses had a health care waste management practices of 31.5% (Muluken *et al.*, 2013), at confidence interval 95%, and power of 80%, the total calculated sample size was 192 nurses.

Sampling technique:

Stratified random sampling technique with proportional allocation was used for getting the required sample of nurses as follows; Different departments and units at Zagazig University Hospitals were classified into 4 main strata where each stratum had nearly the same working conditions; 1) Internal Medicine and Pediatrics Departments, 2) Surgical and Anesthesia Departments, 3) Outpatient Clinics and Blood Bank, and 4) Causality, Intensive Care, and Emergency Departments. The selection of calculated sample of nurses from these strata considered proportional allocation as shown in table (a), then simple random sampling were chosen from each departments' stratum.

Departmental strata	Number of working nurses	%	Sample fraction
1-Medical & Pediatric departments.	820	34.1	65
2- Surgical departments & Anesthesia.	925	38.6	74
3- Outpatient Clinics & Blood Bank.	250	10.4	20
4-Intensive Care & Emergency.	405	16.9	33
Total	2400	100	192

*Inclusion criteria for nurses group***:**

Nurses with at least one year of experience in health care work.

Exclusion criteria for nurses group:

Nurses who refused to participate in the study. So, 5 nurses refuse to participate in the study due to lack of time and 6 nurses were excluded and then the end number of study group was 181 nurses.

*Study tools***:**

1) Format for registration of generated hazardous waste:

A format was used for registration and comparison the quantities of medical wastes generated from different departments and units of the hospital by reviewing weights of hazardous waste of different departments recorded before sending these wastes to incinerator. Checking the accuracy of these recorded data were done by the help of nurses in each department who weighed the medical wastes per day over one week and was found the same as in records. Calculation of amount of waste per bed per day was done by researchers by dividing the weight by the number of occupied beds in the same day and average weight of medical wastes per bed per day was calculated.

2) Questionnaire:

This tool developed by the researchers is based on scientific literature (Sharma *et al*., 2013; Athy, 2009 and WHO, 2010). It consists of three parts;

a) Part one:

Contain demographic data about age, sex, educational qualification, social class, year of experience and department or unit of work.

b) Part two:

Contain self-administered Knowledge Questionnaire Sheet. It consisted of questions covering definition of health care waste, types of health care wastes, classification of hazardous waste, purpose of waste management, methods used for handling and disposal of waste, who are at greater risk to the hazard of waste, sources of health care waste, hazards of health care waste, incineration, precaution in implementing health care waste management, sharps box, chemical bucket, red bags, black bags, nursing trolley, waste management procedures includes cycle of waste management segregation, collection, storage and transportation, sterilization of infectious waste by autoclaving before shredding and disposal, factors that necessary for good waste management system includes waste management documentation, supervision, poster for safe waste handling, resources, budget and maintenance of equipment& facilities and occupational health and safety measures.

c) Part three:

Contain questions about attitude of nurses about medical waste focused on commitment towards use of red bag, sharp container, opinion about incineration of waste, feeling responsibility in managing the problem, feeling about importance of safe management of health care waste, voluntary attendance of programs that enhance and upgrade knowledge about waste management and importance of reporting supervisors about situations not complying with the guidelines for biomedical waste management.

3) Observation Checklist:

Observation checklist for nurses was used to evaluate their practice in different departments about waste management guided by the pertinent literature (El-Sayed *et al.*, 2012 and WHO, 2010). It consisted of items covering some areas related to the knowledge questionnaire includes precaution that nurses follow in health care waste management, their practice toward segregation and collection of waste, use of sharps box, chemical bucket, red bags, black bags & nursing trolley, follow color-coding segregation for medical waste and sterilization of infectious waste before shredding and disposal. Each item was checked as done correctly, not done or not applicable.The scoring system for the observation checklist and questionnaire consisted of giving a score of one for the step done correctly, while the step not done correctly was scored zero.

The awareness and practice score is high if equal or greater than 80%, average if between 60-79% and low if equal to or less than 59%. This measure is based on the bloom's criteria (Blooms, 1956).

*Pilot study***:**

A pilot study was carried out before starting the actual data collection and excluded from sample size to ascertain the clarity, applicability of the study tools and to ensure validity and reliability and to estimate the time needed to fill-in the questionnaire. The study tools didn't need change.

*Ethical issues***:**

Proposal acceptance was obtained from the Institutional Review Board (IRB) of the Faculty of Medicine; Zagazig University and informed consent was obtained from each participant after explaining the purpose of the study and assuring the confidentiality of data.

*Data management***:**

The collected data were presented, summarized, tabulated & analyzed using computerized software statistical package (SPSS version 19) (IBM, 2010). Comparison between group means was done using student's t test and comparison between categorical variables was done by χ^2 test. P- value < 0.05 was considered to be statistically significant.

Results:

Results of assessing the amount of medical waste revealed that the mean values of these waste per day are statistically higher among" the surgical departments & anesthesia department" (45.0±15.0) compared to other departments groups "Internal Medicine Departments and Pediatrics ", " Outpatient Clinics and Blood Bank" and " Causality, Intensive Care, and Emergency" with values and (20.0±3.5, 32.0±4.0 and 30.0±3.2) respectively. The average quantity of the total Zagazig hospitals of Biomedical waste (BMW) per bed per day is 1.5 Kg (Table 1).

Table 1: Quantification of biomedical waste (BMW) among studied departments in Zagazig University Hospitals.

Parameters	1-Medical departments & Pediatrics.	2- Surgical departments& Anesthesia	3- Outpatient Clinics & Blood Bank.	4-Intensive Care & Emergency.	p-value
Quantity of waste per day (mean± SD)	20.0± 3.5	45.0±15.0	32.0±4.0	30.0±3.2	0.000***
Total biomedical waste of Zagazig University hospitals per day per bed = 1.5 kg per day					

Studying the characteristics of the nurses involved in the study showed that the mean values of age of the participants were between 36.4±2.3 and 37±1.2, male participants were 17.7, 5.8, 10.0 and 6.7 % while female participants were 82.2, 94.2, 90.0 and 93.3 % among "medical & Pediatric departments", "Surgical departments & Anesthesia", "outpatient clinics &blood bank", "Intensive Care & Emergency" respectively. The main education was the high nursing school as 80.6, 86.9, 70.0 and 86.7 % among different departments respectively. The socioeconomic status was low and moderate among participants. The years of experience of more than five years are 93.5, 86.9, 75.0 and 90.0 % respectively. No significant difference between the 4 groups in any of the socio-demographic characteristics (Table 2).

Table 2: Socio demographic data among studied groups.

Characteristics	1-Medical & Pediatric departments(n=62)		2- Surgical departments & Anesthesia (n=69)		3- Outpatient Clinics & Blood Bank. (n=20)		4- Intensive Care & Emergency. (n=30)		p-value
Age (Years)	(36.4±1.2)		(36.4±2.3)		(37±1.2)		(36±2.9)		0.5
Sex:	No	%	No	%	No	%	No	%	
F (162)	51	82.2	65	94.2	18	90.0	28	93.3	0.1
M (19)	11	17.7	4	5.8	2	10.0	2	6.7	
Education:									
-High nursing school (150)	50	80.6	60	87.0	14	70.0	26	86.7	
-High nursing institute (20) & Faculty of Nursing (11)	12	19.4	9	13.0	6	30.0	4	13.3	0.3
Socioeconomic:									
-Low (81)	26	41.9	27	39.1	8	40.0	20	66.7	0.1
-Moderate (100)	36	58.1	42	60.9	12	60.0	10	33.3	
Years of experience:									
<5 years (17)	4	6.5	5	7.2	5	25.0	3	10.0	0.1
≥5 years (164)	58	93.5	64	92.7	15	75.0	27	90.0	

The results of questionnaire and checklist showed that there are no statistical significant differences between low "less than or equal to 59%" & average "60-79%" score on one side and high scores "greater than or equal to 80%", on the other among the studied departments as regard awareness and practice (Table 3, 4 and 5); the prevalence of the low & average knowledge scores about biomedical waste (BMW) management is 53.02, 50.7, 60.0 and 60.0 % among " medical & pediatric departments", "surgical departments& anesthesia", "outpatient clinics & blood bank" and " intensive care & emergency" respectively, while the prevalence of high knowledge score is slightly lower than the low & average score (46.8, 49.3, 40.0 and 40.0 % among them respectively).

Table 3: General knowledge about biomedical waste (BMW) management among the studied departments.

Knowledge	1-Medical & Pediatric departments (n=62)		2- Surgical departments & Anesthesia (n=69)		3- Outpatient Clinics & Blood Bank. (n=20)		4- Intensive Care & Emergency. (n=30)		p-value
	No	%	No	%	No	%	No	%	
Low & Average scores (54.2%)	33	53.2	35	50.7	12	60.0	18	60.0	0.79
High scores (45.8%)	29	46.8	34	49.3	8	40.0	12	40.0	

The prevalence of the low & average scores of attitude and practice about biomedical waste (BMW) management are 64.5, 47.8, 60.0 and 66.7 % among "medical,& pediatric departments", "surgical,& anesthesia", "outpatient clinics & blood bank and "intensive care & emergency" respectively, while the prevalences of high score of attitude and practice are slightly lower than the low & average score (35.5, 52.2, 40.0 and 33.3 % among "medical& pediatric departments", "surgical departments& anesthesia", "outpatient clinics & blood bank and "intensive care & emergency" respectively).

Table 4: Attitude about biomedical waste (BMW) management among studied departments.

Attitude	1-Medical departments & Pediatrics. (n=62)		2- Surgical departments & Anesthesia (n=69)		3- outpatient Clinics & Blood Bank. (n=20)		4-Intensive Care & Emergency. (n=30)		p-value
	No	%	No	%	No	%	No	%	
Low & Average scores (58.0%)	40	64.5	33	47.8	12	60.0	20	66.7	0.19
High scores (42.0%)	22	35.5	36	52.2	8	40.0	10	33.3	

Total departments Knowledge, attitude and practice scores of nurses regarding biomedical waste (BMW) management in Zagazig University hospitals indicated that the percentage of those with low & average scores of knowledge are slightly higher than those with high scores as shown "31.5, 22.6 and 45.9 % respectively", also,

the percentage of those with low & average scores of attitude and practice are slightly higher than those with high scores "17.7, 40.3 and 42.0 % respectively" (fig 1).

Table 5: Practice about biomedical waste (BMW) management among the studied departments.

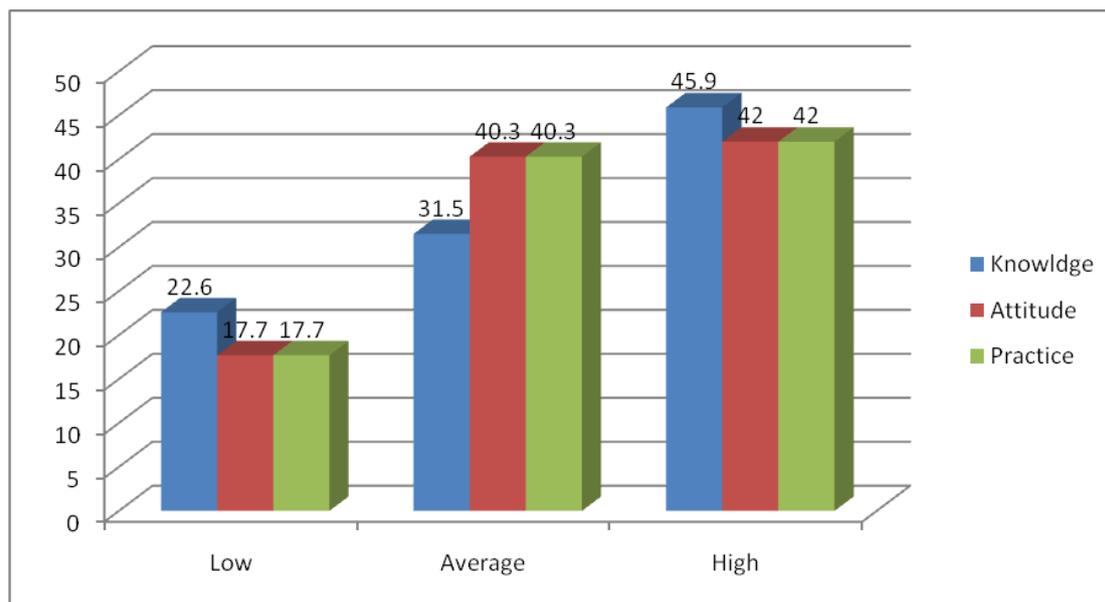| Practice	1-Medical departments & Pediatrics. (n=62)		2- Surgical departments& Anesthesia (n=69)		3- Outpatient Clinics & Blood Bank. (n=20)		4-Intensive Care & Emergency. (n=30)		p-value
	No	%	No	%	No	%	No	%	
Low& Average scores (58.0%)	40	64.5	33	47.8	12	60.0	20	66.7	0.19
High scores (42.0%)	22	35.5	36	52.2	8	40.0	10	33.3	

Fig. 1: Bar chart of total knowledge, attitude and practice of nurses regarding biomedical waste (BMW) management in Zagazig University hospitals.

On comparing the satisfactory (high) and unsatisfactory (low& average)scores of knowledge, attitude and practice by different socio-demographic variables (Table 6& 7); the moderate socioeconomic class had significantly higher knowledge, attitude and practice scores than that of low socioeconomic class. Female and low educational qualification had significantly lower Knowledge, attitude and practice than male and high educational qualification. Otherwise there were no statistical significant differences (between high experienced (≥ 5 years) and low experienced participants (<5 years)) as regard the scores of knowledge, attitude and practice.

Table 6: Socio demographic data and knowledge scores among the studied department.

Socio demographic characteristics	Scores of Knowledge				p-value
	Low& Average scores (N= 98)		High Scores (N= 83)		
	No	%	No	%	
Socioeconomic: status					
Low (N=81)	78	79.6	3	3.6	0.000***
Moderate (N=100)	20	20.4	80	96.4	
Sex:					
F (N=162)	94	95.9	68	81.9	0.002**
M (N=19)	4	4.1	15	18.1	
Education:					
Low (N= 150)	98	100.0	52	62.6	0.000***
High (N= 31)	0	0.0	31	37.4	
Experience:					
<5 years (N=17)	10	10.2	7	8.4	0.8
$\geq$5 years (N=164)	88	89.8	76	91.6	

Table 7: Socio demographic data and Attitude &practice scores among the studied department.

Socio demographic characteristics	Scores of Attitude& Practice				p-value
	Low& Average scores (N= 95)		High Scores (N= 86)		
Socioeconomic status:	No	%	No	%	
Low (N=81)	65	68.4	16	18.6	0.000***
Moderate (N=100)	30	31.6	70	81.4	
Sex:					
F (N=162)	93	97.9	69	80.2	0.000***
M (N=19)	2	2.1	17	19.8	
Education:					
Low (N= 150)	93	97.9	57	66.3	0.000***
High (N= 31)	2	2.1	29	33.7	
Experience:					
<5 years (N=17)	10	10.5	7	8.1	0.5
≥5 years (N=164)	85	89.5	79	91.9	

*** Highly significant.

The questions that showed low responses from the participants of nurses were the health care waste types, documentation and resources management; however, there were no statitistical significant differences between the studied departments in the knowledge, attitude and skills of the low answered questions.

Table 8: Low correct answers among the studied departments.

Low correct answers	1-Medical & Pediatric departments (n=33)		2- Surgical departments & Anesthesia (n=35)		3- Outpatient Clinics & Blood Bank. (n=12)		4- Intensive Care & Emergency. (n=18)		p-value
	No	%	No	%	No	%	No	%	
Types of health care wastes	15	45.4	12	34.3	5	41.7	7	38.9	0.8
Documentation and supervision	15	45.4	13	37.1	6	50.0	5	27.8	0.5
Resources, budget and maintenance of equipments	14	42.4	12	34.3	6	50.0	7	38.9	0.8

Discussion:

About 5 years has elapsed since applying the plan of Ministry of Health for "health care waste management and environmental protection" in Sharkia governorate where Zagazig University Hospitals are present. The plan is regulating hazardous wastes" collection, treatment and disposal"(. So, research studies are required to assess if the implementation of process –improvement actions are satisfactory or not.

All departments and units of Zagazig university hospitals use red bags for hazardous wastes but the amount of these wastes varies considerably between the 4 groups of departments according to the nature of patients care activities. The mean values of BMW waste per day per department are highest among the surgical & anaesthia departments (45.0±15.0 kg) with statistical significance compared to the other groups This may be explained by the high turnover of the dressings and packages used for the operations and postoperative period which are used more in these departments than in any other ones. In agreement with this explanation, the medical and pediatrics departments have the lowest waste production per day (20.0±3.5 kg) while "outpatient clinics & blood bank" and" intensive care & emergency" lie mid-way in BMW production (32.0±4.0 and 30.0±3.2) respectively).

The overall biomedical waste in Zagazig University hospitals was 150.0 -200.0 kg per day (1.5 kg per day per bed). This is in accordance with Saini *et al.* (2005) and Ajai and Nath (2013) who reported that approximately 1-5 kg of biomedical wastes are generated per bed per day, with significant inter country and inter specialty differences. The data from developing countries also indicate a similar range but our study figures are on a lower side with 1-2 kg per day per bed which may indicates a good effect of implementation of a waste segregation program. This is in concordance with a Saudi Arabian study where a hospital was producing a total of 1163 kg of infectious waste per day and after implementation the program, infectious waste was reduced to 407 kg per day (with 65%reduction) (Hagen *et al.*, 2001). In India, it is estimated to be 2.0 kg/ bed/ day while in China the medical waste generation rate ranges from 0.5 to 0.8 kg/bed day (Yong *et al.*, 2009).

In order to sustain a healthy environment, adequate support and development must be given to the workforce specially the nurses through on-the-job training, providing effective means for sound practice and promoting partnerships (Endres, 2008). In health care facilities , nurses are the backbone not only in patient management but also in waste management. A healthy nurse is a better role model, educator, and advocate – personally for the work environment which affects her health as well as patient's health. Nurses are trusted and have the power to make a difference! (ANA, 2014).

Socio-demographic data got by questionnaire showed no significant difference among different specialty groups regarding different socio-demographic variables. This denotes two important things; first that the difference in generated amount of waste is not influenced by these variables, second, the validity of comparing awareness and practice between groups without confounding effect of socio-demographic variables.

The mean age of the participants was above 35 years, hence, the majorities have experience of more than five years and also the majorities were females with nursing school qualification and low or moderate socioeconomic status. These characters are compatible with the declining appointment opportunities in university hospitals.

Nursing staffs who got high score of knowledge, attitude about the biomedical waste (BMW) constituted relatively low percent of participants. This makes sense as the poor knowledge and attitude predict the negative behavior and bad practice toward biomedical waste. This is what was actually met as relatively low percent of participants had high practice scores.

There are no statistical significant differences between low "less than 59%" & average "60-79%" score on one side and high scores "greater than 80%", on the other side among the studied departments as regard knowledge, attitude and practice. The prevalence of the low & average knowledge scores about biomedical waste (BMW) management ranged between 50.7and 60.0 % while low & average scores of attitude and practice about biomedical waste (BMW) management constituted 47.8 to 66.7 %. This is in agreement with Arora and Agarwal (2011) who concluded that majority of the respondents have unsatisfactory knowledge, attitude and inadequate practices related to waste management. The present study has shown a need to improve the knowledge about waste management to protect the environment from the negative impact of waste agreeing with El-Sharkawy (2009). In contrary to the present study, Maja (2005) found that many responses regarding knowledge indicated good awareness about hygiene, but was not being practiced. Inversely, Ajai and Nath (2013) -who stated that knowledge, attitude and practices are not correlated- reported good attitude and practice of BMW management among nurses although their depth of knowledge was relatively low . The better attitude and practice of nurses over physicians in their study can be attributed to the nurses' accountability and commitment in ward management.

The percentage of total nurse participants with low scores of knowledge are much less than those with average or high scores and similarly, the percentage of total nurse participants with low scores of attitude and practice are much less than those with average or high scores. This may be explained by the recently growing role of our infection control unit and its training courses that are running in the hospitals for the health care workers up till this moment. The overall basic knowledge is satisfactory to begin from and more training is necessary to promote positive attitude and better practice. The majorities of participants were competent in their work with average to high score and have heard about BMW and infection control measures.

This is mid way between study of Arora and Agarwal (2011) where the majority of their respondents have unsatisfactory knowledge, attitude and practices related to waste management and the study of Ajai and Nath (2013) who stated that satisfactory knowledge, attitude and practices among nurses are as high as 96.4, 92.8 and 85.7 respectively. Differences among studies may be due to difference in the studies' tools and cut-off for low, average and high.

In comparing the Socio demographic data with scores of knowledge, attitude and practice; the moderate socioeconomic class has higher prevalence of high knowledge, attitude and practice scores. Female and low education has higher prevalence of low & average knowledge, attitude and practice than that of male and high education. This disagree with Ajai and Nath (2013) who attributed the better attitude and practice of nurses over physicians to the predominance of female among nursing workforce and being more concerned with cleanness and proper waste disposal. Effect of education assures that the quality of the education affect not only the knowledge but also the attitude and behavior. Moreover the response to the infection control courses were more from the high female academic nurses who have more awareness about the environmental issues, national and international activities on biomedical waste management and the rules prescribed there.

This was in accordance with Saini *et al*. (2005) who stated that the higher the education the better the knowledge about the biomedical waste. This also comes in line with Sachan *et al*. (2012) who stated that the people with higher education have more awareness about the environmental issues, national and International activities on biomedical waste management.

It was important to determine the questions that showed low responses from the participants of nurses although there were no statitistical significant differences between the studied departments in the knowledge, attitude and skills of the low answered questions. These questions were the types of health care waste, documentation and resources and equipment maintenance. This may be due to other multiple work duties of the nurses, with little stress on the BMW types as it is the concern and duty of the biomedical waste workers.

Conclusion and recommendation:

From this study we can conclude that the hazardous waste generation rate per bed per day in Zagazig University Hospitals is average but the awareness and practice of nurses are relatively unsatisfactory and greatly affected by their socio-economic level, sex and education. So, elevation of socio economic class and education level of nurses especially female together with training programs are important to improve awareness and practice The highest priority to should be given to "surgical departments and anesthesia" group where the largest quantity of waste is generated.

*Limitations of the study***:**

The cross-sectional study design limited the possibility of establishing a causal association between independent variables and dependent variables. The analysis of a causal relationship between the above mentioned factors requires a prospective study. Also, 5 nurses refused to participate in the study because they were too busy. Long time was taken to fill the questionnaire and checklist about 50 min or more.

Competing interests:

The authors declare that there are no competing interests. This research paper was financed totally by the authors of the study .

Contributors:

Nanees Ghareeb designed the study, determined the objectives, designed the questionnaire, conducted the practical phase of the study, edited the whole manuscript and published it. Mona Abu El kheer shared in the practical phase of the study also, analyzed the data statistically, constructed tables and graphs, in addition to writing the discussion. All authors revised the manuscript and have seen and approved the final version.

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