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Current Status of Biomedical Waste Management in Some Universities in Baghdad and Central Public Health of Laboratories

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Abstract: The current status of biomedical waste of solid, liquid and gaseous formulations from medical and educational laboratories in Iraqi universities and research centers was assessed using a well-structured questionnaire. The questionnaire was distributed to scientists, researchers, medical technicians and graduate students who are directly involved in laboratory daily activities. The responses were analyzed statistically and interpreted accordingly. The results showed that the frequency of questionnaire respondent's affiliation gave the highest percentage frequency (69.4%) with the questionnaire of Technical Medical Institute/Al-Mansour while constitute the responses of the Drug Control Department/Ministry of Sciences and Technology gave the lowest percentage frequency of the collected questionnaires (0.9%). Regarding to gender distribution was considered only among participants from two institutes whereas the other numbers were not meaningful. This showed more females participants (79.1%) among the TMI/MTU respondents than males (25.0%). The storage and assembling the chemical in appropriate, non-react able packaginga slightly higher positive response frequency compared to disagreement negative response (39.6 vs. 34.2%, respectively). Although, there were a few questions answered favorably toward a reasonable awareness about the dual use research and technology but it is till unsatisfactory for the rest of the questions raised in this important category. Biological waste management was very poor. All the workers in the study group work except incentral public health of laboratories have not good practices in biowaste management.

Key words: Safety, medical waste, primary treatment, laboratory waste management, interpreted, disagreement

INTRODUCTION

Medical waste is defined by World Health Organization (WHO) as clinical waste resulting from patient operations and clinical specimens and all related to laboratory diagnostic tests within the research centers or resulting from the medical and research laboratories during the training of students. This type of general waste comprises about 10-25% of the total waste whereas the hazardous waste is classified as hazardous if such wastes have an adverse effect on humans and the environment because of their dangerous chemical, physical and biological properties such as waste from pharmaceuticals, dyes, inks, pesticides and fertilizers (Hassan, 2006). Researchers and students who work in the medical, scientific and educational laboratories are at high risk of exposure to hazardous biological and chemical waste. Therefore, it is necessary to find safe and effective methods of waste treatment and a proper waste disposal method.

There must be cooperation and coordination with recognized governmental and non-governmental agencies and sectors within a domestic and international legal framework to implement effective programs for the management and treatment of biomedical waste (Anonymous, 2011). One of the most important aspects to be emphasized for the success of management is the training of researchers and students and all workers in medical, research and scientific laboratories, depending on the type, size and quantity of waste generated from each laboratory. The management and treatment of medical waste is heavily influenced by cultural attitudes, practices, economic and even authority understanding and decisions (WHO., 2006).

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The waste generated by laboratories and research centers, medical and scientific laboratories in universities, includes in fectious waste like the culture media, dissecting products from in fected patients, blood, tissues and clinical specimens handled in diagnostic laboratories. Pathogens may include bacteria, viruses, parasites, fungi and laboratory animals after being injected with infectious agents as well as tools used in experimentation and surgery. WHO estimates that each year there are about 8-16 million new cases of Hepatitis B Virus (HBV), 2.3-4.7 million cases of Hepatitis C Virus (HCV) and 80,000-160,000 cases of Human Immunodeficiency Virus (HIV) due to unsafe injections disposal and mostly due to very poor waste management systems. In addition, personal protective equipment such as gloves, gags, clothing, laboratory coat and other wastes that generated from the activities of from pharmaceutical and toxic products and dealing with recombinant DNA technology and gene manipulation. Chemicals and radioactive waste are another serious hazard that laboratory workers may face daily which have to be treated and disposed properly. Infectious pathogens may enter the human body such as Human Immunodeficiency Virus (HIV), hepatitis viruses and *Mycobacteriu mtuberculosis* through a small wound, mucous membranes by inhalation or by ingestion in contaminated laboratories (Simonsen *et al*., 1999; Dhaifa, 2015).

It is noted that most of the previous studies in Iraq and most Arab countries focused on the management and treatment of medical waste in hospitals and health centers as well as concentrated on ordinary household waste. This study assesses medical waste generated in universities, medical and research laboratories and research centers for the first time in more detail by questioning the workers and scientists who work in these institutes.

MATERIALS AND METHODS

This cross-sectional study was carried out through a random distribution of questionnaire to 111 participants. Participants were laboratory workers, teachers, technicians, administrators, researchers and studentsat the Medical Technical Institute/Al-Mansour, Al-Nahrain, Al-Mustansiriya Universities in Baghdad and the Central Public Health Laboratory. The questionnaire was designed to identify the role of management and treatment of hazardous biomedical waste, types of safe practices to minimize waste risk, sorting, transport and storage of wastes, assessment of the current status of biomedical waste management operations and practices and ascertain main problems that hinder safe disposal of biomedical waste.

Statistical analysis: The answers to the questionnaire were organized in a simple format of agreeing (Yes) or disagreeing (No) with the statement/question asked. The data were analyzed statistically by using statistical package for Social Sciences Program (SPSS) Version 25 for windows system. The Cronbach's alpha statistics were also used to validate reliability of the questionnaire.

RESULTS AND DISCUSSION

This is the first study done in Iraq according to our acknowledgment to evaluate the current status process of medical waste management, treatment and disposal that resulting from the work of medical, scientific and research laboratories in the scientific and research institutions in Iraqi universities in Baghdad. The current results demonstrated that the Cronbach's alpha statistics of questionnaire statements is 0.7.

The frequency of questionnaire respondent's affiliation was summarized in Table 1, the highest percentage frequency (69.4%) was seen in the questionnaire of Technical Medical Institute/Al-Mansour-The Middle Technical University as compared to the universitie's responses Table 1 while constitute the responses of the Drug Control Department/Ministry of Sciences and technology the lowest percentage frequency of the collected questionnaires (0.9%) (Table 1).

Regarding gender distribution was considered only among participants from two institutes whereas the other numbers were not meaningful. This showed more females participants (79.1%) among the TMI/MTU respondents than males (25.0%). While there were more males respondents (45.0 %) among NU participants while zero percentage of frequency was appeared at both of UB and DCD/MST (Fig. 1).

The results of questionnaire indicated that 90% of the respondents don't have biomedical waste management and treatment program in place. This was illustrated by absence of waste containers to each type of biomedical waste, the absence of an incinerator and no storage site available within all institute's participants. These findings suggest that no institution has hadthe essential requirements for medical waste management and treatment. It worth noted that 10% of the respondents failed to respond in the questionnaire to answer this part of the questionnaire.The questionnaire was designed to include five parts: the legal framework, laboratory safety

Table 1: Affiliation of participants in questionnaire distribution

Institute	Number	Percentage	Valid (%)	Cumulative (%)
Al-Nahrain University (NU)	24	21.6	21.6	21.6
AlMansour Technical Medical Institute, The Middle Technical University (TMI/MTU)	77	69.4	69.4	91.0
Public Health Central Laboratories, Ministry of Health (PCL/MH)	4	3.6	3.6	94.6
Technology University (TU)	2	1.8	1.8	96.4
University of Baghdad (UB)	3	2.7	2.7	99.1
The Drug Control Department, Sciences and Technology (DCD/MST)	1	0.9	0.9	100.0
Total	111	100.0	100.0	

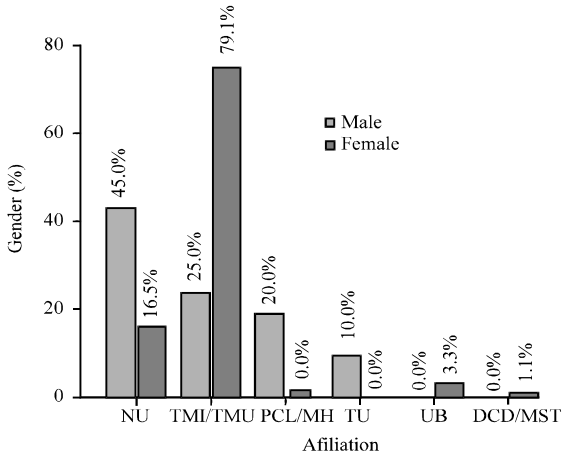

Fig. 1: Gender distribution of questionnaire respondents according to the affiliation

and security, conduct basics, dual-use materials and misuse of biomedical waste. Seven questions were about the legal framework included: the number of students in the laboratory, laboratory chemical materials file box and the follow-up employees, awareness of the use and non-abuse of dual-use chemicals by postgraduate students.

The results of the legal framework seven questions showed a high percentage frequency for disagreement (No) responses compared with agreement (Yes) responses (77.5 vs. 20.7%, 46.8 vs. 30.6%, 73.0 vs. 11.7%, 65.8 vs. 24.3%, 62.2 vs. 22.5% and 45.9 vs. 13.5%, respectively), (Table 2). On the contrary, the 6th question (the storage and assembling the chemical in appropriate, non-react able packaging) in this part showed a slightly higherpositive response frequency compared to disagreement negative response (39.6 vs. 34.2%, respectively). This suggests that there were remarkable deficiency in fulfilling the requirements for management and treatment the medical waste in the majority of the institute's involved in this survey.

The second part which deals with the laboratory safety and security included four questions were on the presence of a medical waste management and handling officer, committee or unit, holding periodic meetings, primary treatment of the very infectious medical waste in the site of collection, a specific program for collecting and transporting the waste to the storage room and the suitable method for disposing the medical waste such as a syringe (Table 3). Results showed a high percentage frequency of participants answered by no compared to Yes responses for four questions as follows: 74.8 vs. 23.4%, 76.6 vs. 18.9%, 65.8 vs. 29.7%, 77.5 vs. 18.0%, respectively, Table 3. Except a question about the recapped (recovered) the needle of the syringe before placing the syringe was positively answered by 45.9% opposite to 24.3% no answers. In general, these data indicate that the requirements for laboratory safety and security were well below the standard level required to be established in research and medical laboratories that those participants came from. This highlights the alarm for action to be taken regarding capacity building of safety and security in these Institutes.

While the third part of questionnaire questions which was dealt with behaviors and attitudes basics included four questions about the presence of a specialized guides for sorting the medical wastes, a suitable specification of the medical wastes tools and a specialized worker provided with the suitable PPE (Table 4). Analyzed responses showed a high percentage frequency for No responses compared to yes responses for all questions (91.0 vs. 4.5%, 43.2 vs. 38.7%, 79.3 vs. 9.9% and 81.1 vs. 8.1%, respectively). These findings indicated a striking lack of proper guidelines for attitude and behavior among the workers in these Institutes.

The fourth part of the questionnaire questions studied the dual use materials as assessed by thirteen questions that include thepresence of guidance boards and posters that hanging in prominent places, medical waste bags and containers, medical waste bags with a protective covering and can be opened by foot pressure and matching the color of the bag, a labeling card is placed on bags and containers, the capacity of the bags is proportional to the amount of waste inside, waste is not left in place for more than 1 day in Summer and 2 days in Winter, a new package or bag shall be placed in

Table 2: Participant's responses to the legal frame work questions

Questions	Frequency	Percentage	Valid (%)	Cumulative (%)
Question 1 response frequency (The presence of a manual guide for the management and disposal of medical waste for workers)				
No	86	77.5	78.9	78.9
Yes	23	20.7	21.1	100.0
Total	109	98.2	100.0	
Missing	2	1.8		
Total	111	100.0		
Question 2 response frequency (The plastic bags and containers made of non-halogenated plastic)				
No	52	46.8	60.5	60.5
Yes	34	30.6	39.5	100.0
Total	86	77.5	100.0	
Missing	25	22.5		
Total	111	100.0		
Question 3 response frequency (Sharps plastic containers of the special waste are suitable and non-reopen)				
No	81	73.0	86.2	86.2
Yes	13	11.7	13.8	100.0
Total	94	84.7	100.0	
Missing	17	15.3		
Total	111	100.0		
Question 4 response frequency (The bags and containers are filled up to two thirds of size only)				
No	73	65.8	73.0	73.0
Yes	27	24.3	27.0	100.0
Total	100	90.1	100.0	
Missing	11	9.9		
Total	111	100.0		
Question 5 response frequency (Packets and bags are available in sufficient numbers within sections)				
No	38	34.2	46.3	46.3
Yes	44	39.6	53.7	100.0
Total	82	73.9	100.0	
Missing	29	26.1		
Total	111	100.0		
Question 6 response frequency (Chemical waste is sorted and assembled into appropriate, non-reactivable packaging)				
No	69	62.2	73.4	73.4
Yes	25	22.5	26.6	100.0
Total	94	84.7	100.0	
Missing	17	15.3		
Total	111	100.0		
Question 7 response frequency (The room space suitable with wastes size)				
No	51	45.9	77.3	77.3
Yes	15	13.5	22.7	100.0
Total	66	59.5	100.0	
Missing	45	40.5		
Total	111	100.0		

place of the packaging or bag filled with waste immediately. The path leading to the medical waste storage room does not pass through food preparation and sanitation facilities, cleaning tools, water source and sewage disposal point are available in the storage room, the ventilation and lighting are adequate inside the storage room, the storage room has a door that is always closed and sealed and animals, birds and insects cannot enter storage rooms (Table 5). Results showed a higher percentage frequency for No responses compared to Yes responses for the first 9 questions (67.6 vs. 30.6%, 76.6 vs. 23.4%, 82.9 vs. 17.1%, 73.9 vs. 17.1%, 62.2 vs. 11.7%, 36.0 vs. 30.6%, 39.6 vs. 14.4%, 35.1 vs. 32.4% and 35.1 vs. 13.5%, respectively). While the last four questions, the frequency of responses were higher for Yes rather than No (55.9 vs. 44.1%, 52.3 vs. 37.8%, 62.2 vs. 23.4% and 38.7 vs. 28.8%, respectively). Again, although, there were a few questions answered favorably toward a reasonable awareness about the dual use research and technology but it is till unsatisfactory for the rest of the questions raised in this important category. This highlight the importance of including specific topics in the teaching and training programs in all academic and research Institutes in Iraq.

Finally, the results of the fifth part of the questionnaire questions about the misuse of the chemical and biological materials within the assessed Institutes showed thata high percentage response frequency for No responses compared with Yes responses (67.6 vs. 16.2%, respectively) (Table 6). This single question about the use of biological and chemical materials indicated a lack of knowledge about the proper guideline about avoiding the danger of misuse and handling of biomedical wastes in these institutes.

The cumulative findings of the 5 parts of this questionnaire indicated that there was substantial

Table 3: The laboratories safety and security question 1 response frequency (The second questionnaire axis)

Questions	Frequency	Percentage	Valid (%)	Cumulative (%)
Question 8 response frequency (The presence of a medical waste management and handling officer in the institution)				
No	83	74.8	76.1	76.1
Yes	26	23.4	23.9	100.0
Total	109	98.2	100.0	
Missing	2	1.8		
Total	111	100.0		
Question 9 response frequency (The presence of a medical waste management committee or unit in the institution and periodic meetings are held)				
No	85	76.6	80.2	80.2
Yes	21	18.9	19.8	100.0
Total	106	95.5	100.0	
Missing	5	4.5		
Total	111	100.0		
Question 10 response frequency (Primary treatment of highly infectious waste is carried out at the collection site)				
No	63	56.8	65.6	65.6
Yes	33	29.7	34.4	100.0
Total	96	86.5	100.0	
Missing	15	13.5		
Total	111	100.0		
Question 11 response frequency (Presence a specific program for collecting and transporting the waste to the storage room)				
No	86	77.5	81.1	81.1
Yes	20	18.0	18.9	100.0
Total	106	95.5	100.0	
Missing	5	4.5		
Total	111	100.0		
Question 12 response frequency (Is the needle of syringe recapped (recovered) before placing the syringe)				
No	27	24.3	34.6	34.6
Yes	51	45.9	65.4	100.0
Total	78	70.3	100.0	
Missing	33	29.7		
Total	111	100.0		

Table 4: Behaviors basics (the third questionnaire axis)

Questions	Frequency	Percentage	Valid (%)	Cumulative (%)
Question 13 response frequency (The resulting medical waste is sorted according to the guide in all sections)				
No	101	91.0	95.3	95.3
Yes	5	4.5	4.7	100.0
Total	106	95.5	100.0	
Missing	5	4.5		
Total	111	100.0		
Question 14 response frequency (The thickness of medical waste bag is fitting)				
No	48	43.2	52.7	52.7
Yes	43	38.7	47.3	100.0
Total	91	82.0	100.0	
Missing	20	18.0		
Total	111	100.0		
Question 15 response frequency (Provide specialized workers to transport the medical waste)				
No	88	79.3	88.9	88.9
Yes	11	9.9	11.1	100.0
Total	99	89.2	100.0	
Missing	12	10.8		
Total	111	100.0		
Question 16 response frequency (The workers are provided with appropriate personal protective equipment)				
No	90	81.1	90.9	90.9
Yes	9	8.1	9.1	100.0
Total	99	89.2	100.0	
Missing	12	10.8		
Total	111	100.0		

Table 5: Participant's response frequency on thirteen questions about the dual use research and technology

Questions	Frequency	Percentage	Valid (%)	Cumulative (%)
Question 17 response frequency (Provide guidance boards and posters hanging in prominent places within the sections for medical waste and treatment methods)				
No	75	67.6	68.8	68.8
Yes	34	30.6	31.2	100.0
Total	109	98.2	100.0	
Missing	2	1.8		
Total	111	100.0		

Table 5: Continue

Questions	Frequency	Percentage	Valid (%)	Cumulative (%)
Question 18 response frequency (Availability of medical waste bags and containers)				
No	85	76.6	76.6	76.6
Yes	26	23.4	23.4	100.0
Total	111	100.0	100.0	
Question 19 response frequency (Medical waste bags are available with a protective covering and can be opened by foot pressure and matching the color of the bag)				
No	92	82.9	82.9	82.9
Yes	19	17.1	17.1	100.0
Total	111	100.0	100.0	
Question 20 response frequency (The capacity of the bags is proportional to the amount of waste inside)				
No	49	44.1	44.1	44.1
Yes	62	55.9	55.9	100.0
Total	111	100.0	100.0	
Question 21 response frequency (Waste is not left in place for more than one day)				
No	42	37.8	42.0	42.0
Yes	58	52.3	58.0	100.0
Total	100	90.1	100.0	
Missing	11	9.9		
Total	111	100.0		
Question 22 response frequency (A labeling card is placed on bags and containers)				
No	82	73.9	81.2	81.2
Yes	19	17.1	18.8	100.0
Total	101	91.0	100.0	
Missing	10	9.0		
Total	111	100.0		
Question 23 response frequency (A new package or bag shall be placed in place of the packaging or bag filled with waste immediately)				
No	26	23.4	27.4	27.4
Yes	69	62.2	72.6	100.0
Total	95	85.6	100.0	
Missing	16	14.4		
Total	111	100.0		
Question 24 response frequency (The path leading to the medical waste storage room does not pass through food preparation and sanitation facilities)				
No	69	62.2	84.1	84.1
Yes	13	11.7	15.9	100.0
Total	82	73.9	100.0	
Missing	29	26.1		
Total	111	100.0		
Question 25 response frequency(Cleaning tools, water source and sewage disposal point are available)				
No	32	28.8	42.7	42.7
Yes	43	38.7	57.3	100.0
Total	75	67.6	100.0	
Missing	36	32.4		
Total	111	100.0		
Question 26 response frequency (Animals, birds and insects cannot enter storage rooms)				
No	40	36.0	54.1	54.1
Yes	34	30.6	45.9	100.0
Total	74	66.7	100.0	
Missing	37	33.3		
Total	111	100.0		
Question 27 response frequency (The storage room has a door that is always closed and sealed)				
No	44	39.6	73.3	73.3
Yes	16	14.4	26.7	100.0
Total	60	54.1	100.0	
Missing	51	45.9		
Total	111	100.0		
Question 28 response frequency (Ventilation and lighting are adequate inside the storage room)				
No	39	35.1	52.0	52.0
Yes	36	32.4	48.0	100.0
Total	75	67.6	100.0	
Missing	36	32.4		
Total	111	100.0		
Question 29 response frequency (Storage is not more than 24 h in Summer and 48 h in Winter)				
Yes	15	13.5	27.8	100.0
Total	54	48.6	100.0	
Missing	57	51.4		
Total	111	100.0		

Table 6: The misuse of the materials (the fifth axis)

Questions	Frequency	Percentage	Valid (%)	Cumulative (%)
Question 30 response frequency (Storage room present inside the institution)				
No	75	67.6	80.6	80.6
Yes	18	16.2	19.4	100.0
Total	93	83.8	100.0	
Missing	18	16.2		
Total	111	100.0		

deficiency in knowledge and awareness about biomedical waste management, treatment and disposal by the majority of respondents from different institutions in Baghdad. Therefore, urgent needs for education and training ofall staff and students who come in direct or indirect contact with handling or disposing of biomedical waste. Authorities have to signify the alarm for action about building detailed Standard Operating Procedures (SOPs), process guidelines and warning and compliance safety and security signs in laboratories and buildings. Most important a designed curriculum for teaching laboratory safety and security for undergraduates and postgraduate students prior to commencing their laboratory practical and research projects. Additionally, it is necessary to legislatestrict instructions and regulations across the country in order to reduce people exposure to the hazardous materials and lessen the environmental pollution resulted from the misuse of biological and chemical dual use materials.

In the absence of guideline about the correct handling and disposal of biomedical waste, we have to consider the most vulnerable people who work in cleaning services and laboratory workers as they come in direct contact with hazardous biomedical waste. Therefore, those people should be the main target for future education and training programs. It gets more serious when those most affected people had skin injuries or wounds that can resulted from acupuncture, contaminated sharp instruments, syringes, broken glass, contaminated cotton and gauze, etc. In addition to direct contact and blood routes, the other important route that has to be aware of is the inhalation of volatile dust containing microorganisms or air circulation within facilities for those who work outside protective containments or fume hoods in these educational institutions. Moreover, most of these institutions under study lack the presence of the waste treatment facilities such as incinerators for solid and sharp waste and liquid waste treatment prior to release to the sewerage system. Without such facilities, some microorganism particularly those have spores or resistant microbes (clostridium species and anthrax) and viruses still can survive under low temperature or under less effective treatment.

A study on the management of medical waste at Amderman Medical Hospital, National Ribat University in Morocco showed that compliance with waste management rules and regulation by hospital male (31.8%) and female (68.2%) workers was 93.3% compared to 6.7% non-compliance (Dhaifa, 2015), particularly on the availability of special containers and baskets for disposal of medical waste in their facility. Whether a medical waste is sorted from the normal waste in laboratories, the proportional answers were positives (Yes) (70.5%) and 29.5% were negative answers (No). This indicates that still a risk exist in a third of waste disposing. In the same study, the fund availability for disposing hazardous medical waste was questioned and those who respond yes 65.9% compared to 34.1% who answered no. There were 60% compliance of wearing PPE in the laboratories. On the other hand and similar finding to this study, there was 80% failure in making waste management guidance manual publically available to staff. The latter is very close to the finding of this study regarding information and regulation as well as there was no official officer responsible for waste management and 86.4% of bad practice of recapping the needle syringes back after use.

The percentage of holders of the bachelor's degree was 79.5% and the percentage of holders of a doctorate and master's degree was 6.3% and this not compatible with present study. Our results are compatible with the results in Syria was done by Sonia and Wahba (2006). They found that the lack of sufficient awareness of the seriousness of medical waste in Syria has led to weak application of laws to manage waste properly. There is no sorting of medical waste by type, collection of waste in bags without reference to their content and the transfer of waste by hand without the use of vehicles and there is no special place to store them. Also, our results are agreed with results in Central African Republic in 2016; They found that 29% of the workers in two medical laboratories in Bangui used safety boxes and biological wastes transporting was manual. Most of workers (about 64%) in laboratories had not received training on biomedical wastes (Balekouzou *et al*., 2016). But Shabib and Khalifa in Al-Kut Governorate/Iraq found that all the health care workers under study in Primary Health Care Centers had good practices post the program implementation and perform the principles of waste management practices in better way (Shabib and Khalifa, 2016). In Al-Diwaniyah

government hospitals, the researchers revealed that all incinerators were old and the medical waste-cancer which threat the human cells and cause congenital malformations and stimuli mutations were not isolated from other medical waste in hospitals. So, this materials will threat the lives of workers; Health of citizens in addition to environment. The weakness in waste management training conceder one reason for pollution in hospital in Al-Diwaniyah (Hamadan and Jasim, 2017).

In India like in Iraq, the biomedical waste programs had been widely discussed to overall hospital waste management but pathology and microbiology laboratories generate high proportion of biomedical waste and had not received much attention and this will lead to more pollution and infectious diseases (Chitnis *et al*., 2005). So, the practices required in biomedical wastes management and application of the law to protect and improve the Iraqi environment (Al-Jwaly and Saleh, 2013). In teaching hospitals in Mosel city, the biomedical waste management is more regular in Baghdad, the bio medical waste is identified by a colored code and the workers are used the medical containers and bags. But there is a lack of replacing them with new containers (Abdullah and Salwa, 2013). In Nepal, most of biomedical wastes were not treated before transportation to waste disposal sites (Anonymous, 2004) like in medical laboratories under our study.

CONCLUSION

Because of the economic cost of disposal of hazardous medical waste in most countries of the world, including Iraq and Algeria, so, these wastes began to cause significant pollution to the environment and public health (OSHA., 2002; Samerkhanova, 2006).

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