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ASSESSMENT OF HEALTHCARE WASTE MANAGEMENT IN HOSPITALS OF SOUTH LEBANON

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Abstract

Healthcare wastes (HCW) are produced in any healthcare setting during diagnosis, medical care, operation or injection process or during research studies. The management of such wastes is becoming a great issue since they pose many health risks and environmental damage. Hence, this study was carried out to assess the level of healthcare waste management in hospitals of South Lebanon. A cross sectional study was conducted in five hospitals located in South Lebanon (A, B, C, D and E). The Individualized Rapid Assessment Tool (I-RAT) developed in 2009 as part of the UNDP GEF Global Project on Healthcare Waste, was the instrument used for data collection. A part of the IRAT-HCWM questionnaire was completed through on site observation and the other part of the questionnaire was filled by the nurses, nurse managers, quality and environmental managers and infection control managers in different wards of the hospitals. In general, the five evaluated hospitals showed a good management of healthcare wastes. However, there are still unsatisfactory practices in these hospitals regarding policies, regulations, procedures, safety issues and awareness. Thus, future interventions are required in order to improve the healthcare waste management practices in hospitals of South Lebanon.

Keywords

Healthcare waste, Healthcare waste management, Hospitals, Infectious wastes, South Lebanon

1. INTRODUCTION

Healthcare waste (HCW) corresponds to all materials (biological and non-biological), which are eliminated but not planned for another use. They are produced in hospitals, research facilities, medical institutes, clinics, laboratories, blood banks, animal houses and centers of veterinary practice. In hospitals these types of wastes are generated for variety of reasons such as patient diagnosis, care or immunization and biomedical research associated with it (Lakbala & Mahesh, 2011). Healthcare waste management is becoming a major issue because it causes wellbeing hazards and harm to the environment that has a high tendency to trigger epidemics (Awodele et al., 2016).

Healthcare waste management (HCWM) is really an important problem for the nature and general population because of its potential for infection and/or toxicity (Maamari et al., 2015). While 75-90% of the wastes are general waste with no probable risk, 10-25% are considered dangerous, posing a possible hazard to health care professionals, patients, staff, the surrounding as well as the overall population, if not properly disposed of (Askarian et al., 2010)

HCW consists of infectious healthcare waste (IHCW) and other wastes that include various categories such as chemicals (Polyvinyl Chloride Plastics (PVC), laboratory reagents, heavy metals/mercury, solvents), pharmaceuticals (expired drugs, vaccines), pathological waste (human tissues), genotoxic waste (carcinogenic, mutagenic and chemotherapy medicines), sharps (scalpels, needles) and radioactive waste (radiotherapy). IHCW (blood-contaminated waste, secretions, and bodily fluids) is just the category of waste suspected of containing any type of microorganisms in adequate intensity or amount to induce illness in vulnerable hosts (Maamari *et al.*, 2015). World Health Organization (WHO) reports that over 50,000 persons are dying from contagious diseases every day due to improper waste management (WHO, 2014). The main hazardous diseases that can be transmitted via improper waste management are Human Immunodeficiency Virus (HIV), hepatitis, pneumonia, diarrheal diseases, tuberculosis, whooping cough and tetanus (Lakbala & Mahesh, 2011). Other potential risks can involve microorganisms resistant to drugs that can be transmitted to the environment from any health setting (WHO, 2018).

Toxicity in hospitals is defined by the presence of remarkable quantities of hazardous waste like mercury and lapsed medications (Awodele *et al.*, 2016). Damages to the airways , skin, eyes or mucosa may happen through contact with these harmful substances (WHO, 2014).

In hospitals, the effective management and safe disposal of HCW is important in reducing infection or disease when become in contact with thrown products and in preventing contamination of the environment (Idowu *et al.*, 2013).

The healthcare sector in Middle East and North Africa (MENA) world is growing rapidly, resulting in a massive raise in the quantity of HCW waste produced by hospitals, clinics and other institutions. Incorrect disposal methods, limited physical resources and lack of research on the management of medical waste exacerbate this case. These dangerous wastes are combined with municipal and industrial wastes in many MENA countries which turn them into a mixture of hazardous substances that lead to the transmission of diseases, and contamination of water, soil and air (Yazie et al., 2019).

Imperfect HCWM is a challenge in most developing nations (Yazie *et al.*, 2019)(Karam et al., 2000). In Lebanon , hospital waste management faces both an environmental problem and a global health threat as a result of the absence of regulations, knowledge and advanced systems for treatment and disposal (Karam *et al.*, 2000). Indeed, the raise in the rate of waste production in most hospitals in Lebanon proposes that these wastes are not regulated and there is a poor auditing system (Maamari *et al.*, 2015). Currently, there is a lack of studies about HCW management level in South Lebanon. Therefore, the aim of the study was to assess the level of HCWM in hospitals of South Lebanon.

2. MATERIALS AND METHODS

2.1 Study Site and Duration

The study was conducted at five hospitals in South Lebanon including one governmental and four private hospitals between October 2019 and January 2020. The number of beds in each facility is as the following: 88 bed in hospital A, 85 bed in hospital B, 130 bed in hospital C, 135 bed in hospital D, and 125 bed in hospital E.

2.2 Study Design

The study design was descriptive cross-sectional to assess the level of HCWM in hospitals of South Lebanon.

2.3 Study Procedure and Tool

One visit to each hospital was performed in order to monitor the HCWM practice. Data were collected about all the steps of waste management starting from waste generation, collection and handling, segregation, storage, transportation, treatment (on- site and off- site) until the disposal process by filling the Individualized Rapid Assessment Tool (I-RAT) questionnaire. A part of the IRAT-HCWM questionnaire was completed through on site observation and the other part of the questionnaire was filled by the nurses, nurse managers, quality and environmental managers and infection control managers in different wards of the hospitals. Data involved average scores that were established from the compliance of I-RAT.

I-RAT developed in 2009 as part of the UNDP GEF Global Project on Healthcare Waste by Dr. Jorge Emmanuel(Sapkota et al., 2014). It is comprised of a series of questions. Most questions can be answered by a YES or NO. Others require numerical or text answers. After that a final score was automatically determined by the I-RAT. The higher the final ranking, the better the hospital's HCWM program. The scores have been transformed into percentages. The "Yes or Y" showed the availability and the "No or N" showed the unavailability. Sites were then classified as 0-25% (very poor), 26-50% (poor), 51-75% (good), and 76-100% (excellent) depending on the percentage.

2.4 Data Analysis and Presentation

We used Microsoft Excel software for data entry and analysis.

2.5 Ethical Consideration

This work was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) and submitted to the Institutional Review board IRB at Beirut Arab University for ethical approval. Also, approval from hospitals was obtained by sending permission letter and anonymity of the hospitals was maintained in which no names were recorded. A verbal consent was obtained from participants since there was less than minimal risk.

3. RESULTS

3.1 Organization, Policy and Planning

The five hospitals had a person in charge of healthcare waste management. Hospitals C, D and E, but not A and B, had a permanent committee that meets on a regular basis. Roles and responsibilities regarding HCWM were made clear to staff in all the hospitals. Written policies, plans, manuals and written procedures dealing with HCWM consistent with national laws and regulations were present in the five hospitals. Unfortunately, there was no plan for waste minimization in all hospitals. Hospitals B and D only didn't show a commitment to protect the environment. The majority of the hospitals had a plan to phase out mercury except facility B. Based on the I-RAT, hospitals C and E got the best score (17.5/19), followed by hospital D then A with scores (17/19) and (16/19) respectively, while the worst was for hospital B with a score (14/19) (Table 1).

Table 1: Evaluation of Organization, Policy and Planning Practices.

3.2 Training, Occupational Health and Safety

Score / Organization, Policy and Planning	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
In charge of HCWM.	Y	Y	Y	Y	Y
Permanent committee that deals with HCWM and meets on a regular basis.	N	N	Y	Y	Y
Roles and responsibilities regarding HCWM made clear to the staff.	Y	Y	Y	Y	Y
HCF has written policies dealing with HCWM.	Y	Y	Y	Y	Y
HCF has written plans, manuals, or written procedures dealing with HCWM.	Y	Y	Y	Y	Y
Policies, plans, manuals, and/or written procedures consistent with national laws, regulations, and any permits.	Y	Y	Y	Y	Y
HCF has a plan for recycling or waste minimization.	N	N	N	N	N
HCF policy explicitly mentions a commitment to protect the environment.	Y	N	Y	N	Y
HCF is a mercury-free or HCF has a policy or plan to phase out mercury.	Y	N	Y	Y	Y
Total	16	14	17.5	17	17.5

The five hospitals had a training program on HCWM for managers, health professionals, waste workers, and auxiliary staff that included relevant national laws and regulations. However, the training program in all hospitals did not include the full list of steps of waste management. Staff were trained, including the new one, and a refresher training was done at least once a year in all the hospitals.

All hospitals had policies and plans that included needle- sticks and exposure to blood, but none was provided with the proper personal protective equipment (PPE) for the workers. None of the five hospitals were given tetanus vaccination for health workers and workers handling waste except hospital E. On the other hand, hepatitis B vaccination was given in the majority of hospitals except in hospital B. Based on the I-RAT, the best score was for hospital E (15/19) while the remaining hospitals got the same score (13/19) (Table 2).

Table 2: Evaluation of training and occupation health and safety practices.

Score / Training, Occupational health and safety	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
HCF has a training program on HCWM for managers, health professionals, waste workers, and auxiliary staff.	Y	Y	Y	Y	Y
Training program includes relevant national laws and regulations.	Y	Y	Y	Y	Y
Training program includes segregation, collection and handling of sharps waste, use of proper containers and bags for infectious waste, color coding, 3/4 fill rule, use of personal protection equipment by waste workers, transport, storage, and treatment.	N	N	N	N	N
Staffs are trained, including new staff when they begin their employment.	Y	Y	Y	Y	Y
Refresher training at least once a year.	Y	Y	Y	Y	Y

Continue Table 2

Policies and plans related to HCWM include occupational health and safety (including policies for NSI or exposure to blood splatter). OR HCF has separate occupational health and safety policies that include needle-sticks and exposure to blood.	Y	Y	Y	Y	Y
Workers who collect, transport and treat waste are provided with PPE (gloves, shoes or boots, and aprons).	N	N	N	N	N
Health workers and workers handling waste are given vaccinations for hepatitis and tetanus	N	N	N	N	Y
Total	13	13	13	13	15

3.3 Monitoring, Evaluation, Corrective Action and Financing

The five hospitals had a system of internal monitoring to determine the compliance with HCWM requirements, and a system of taking corrective action when practices to HCWM do not meet the requirements. However, policies and plans were not reviewed at least once a year in hospitals A, B, C, and D except in hospital E. Regarding financing, only hospitals A and E had an annual allocation in their budgets for HCWM. The results obtained indicated that the current budget was sufficient only in hospitals D and E. In addition, only facility A had a long-term financing plan to cover the costs for sustainable HCWM. Based on the I-RAT, Hospital E got the best score (8.5/9), followed by hospital A then D with scores (6.5/9) and (4/9) respectively while the worst scores were for hospitals B and C with score (2/9) (Table 3).

Table 3: Evaluation of monitoring, corrective action and financing practices.

Score / Monitoring, Evaluation, Corrective Action and Financing	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
System of internal monitoring or inspection to determine compliance with HCWM requirements.	Y	Y	Y	Y	Y
System of taking corrective action when practices or technologies related to HCWM do not meet the requirements.	Y	Y	Y	Y	Y
Policies and/or plans are reviewed or updated at least once a year.	N	N	N	N	Y
HCF has an annual allocation in its budget for HCWM.	Y	N	N	N	Y
Current budget is sufficient for HCWM.	N	N	N	Y	Y
HCF has a long-term financing plan or mechanism to cover the costs for sustainable HCWM.	Y	N	N	N	N
Total	6.5	2	2	4	8.5

3.4 Classification, Segregation and Waste Generation

The results showed that wastes were not properly segregated at the source according to different categories in all hospitals. However, the health workers were familiar with the classification and segregation requirements in hospitals A, C, D and E except for hospital B. None of the hospitals measured the amounts of total and infectious waste per day and thus no percentages of infectious waste relative to total waste and kilograms of unrecycled waste per bed were obtained. The five hospitals produced regular waste, infectious waste, pharmaceutical waste, chemical waste, sharp waste and pathological waste. The majority of hospitals produced radiological waste except hospital B. Based on the I-RAT, Hospitals A, C, D and E got the same score (2/9), while the worst score was for hospital B with a score (0) (Table 4).

Table 4: Evaluation of classification, segregation and waste generation practices

Classification, Segregation and waste generation / Score	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
Wastes are properly segregated at the source, according to different categories.	N	N	N	N	N
Health workers are familiar with the classification and segregation requirements.	Y	N	Y	Y	Y
Amounts of total waste and infectious waste produced per day has been measured.	N	N	N	N	N
Percentage of infectious waste relative to total waste.	N	N	N	N	N
Kilograms unrecycled waste per bed per day.	N	N	N	N	N
Total	2	0	2	2	2

3.5 Collection and Handling

The results showed that used syringe needles were collected without recapping in hospitals A and E while there were some cases of recapping in the rest of hospitals. On the other hand, all hospitals collected sharps waste in sharp container that were puncture resistant and leek proof. In addition, these containers were filled only ¾ in all hospitals except in hospital B. Moreover, sharps containers were always available in the five hospitals, but they were not easily accessible to personnel in hospital B. The results indicated that apart from hospital A and B, others were familiar with the policy of needle-stick injury (NSI). In all hospitals, the plastic bags used for non-sharps infectious waste were always available, and were of good quality as well as their hard containers. Moreover, infectious wastes were removed at least once a day all hospitals. However, waste workers were familiar with the spill clean-up plans only in hospitals C and E.

All hospitals used black plastic bag for regular wastes, yellow for infectious wastes and yellow sharp box for sharps. Hospitals C, D and E used red plastic bag for chemical wastes while hospital B used the purple bag. In addition, regarding pharmaceutical wastes, hospitals B, D and E used the red plastic bag while hospital C used the blue one. For pathological waste, hospital B used white plastic bag while hospital C used the silver bag. Based on the I-RAT, Hospital E got the best score (19/19), followed by hospital A, C then D with scores (17.5/19), (17/19) and (16.5/19) respectively while the worst score was for facility B with a score (11.5/19) (Table 5).

Table 5: Evaluation of collection and handling practices.

Score / Collection and Handling	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
Uses syringe needles are collected without recapping.	Y	N	N	N	Y
Sharps waste are collected in sharps container or destroyed using needle destroyers.	Y	Y	Y	Y	Y
Sharps containers are puncture resistant and leak proof. Or needle destroyers are approved under existing regulations or standards.	Y	Y	Y	Y	Y
Sharps containers are filled only 3/4 full. OR needle destroyers are well maintained.	Y	N	Y	Y	Y
Sharps containers or needle destroyers are always available.	Y	Y	Y	Y	Y
Sharps containers OR needle destroyers are properly placed such that they are easily accessible to personnel and located as close as possible to the immediate area where the sharps are used.	Y	N	Y	Y	Y
Health workers know what to do in the event of a needle stick injury. OR health workers are familiar with the policy on NSI.	N	N	Y	Y	Y

Continue Table 5

Plastic bags are used for non-sharps infectious waste of good quality. OR specialized containers that are disinfected, cleaned and reused and do not require plastic bags are used.	Y	Y	Y	Y	Y
Plastic bags are always available. OR specialized containers described in #33 are always available.	Y	Y	Y	Y	Y
Bag holders or hard containers holding the plastic bags are of good quality. Specialized containers that are disinfected, cleaned and reused and do not require plastic bags are used.	Y	Y	Y	Y	Y
Infectious wastes are removed at least once a day.	Y	Y	Y	Y	Y
Waste workers know what to do if sharps or infectious waste is accidentally spilled. OR waste workers are familiar with the spill clean-up plans.	N	N	Y	N	Y
Total	17.5	11.5	17	16.5	19

3.6 Color-Coding, Labelling and Posters

Hospitals B, C, D and E used a system of color-coding for different types of wastes. In the five hospitals, not all containers were consistent with color-coding. On the other hand, all of them used infectious waste bags that were colored in accordance with the policies. Regarding posters or signs showing proper segregation of healthcare waste, they were in hospitals C and D only. Based on the I-RAT, Hospitals C and D got the best scores (4.5/6.5) followed by hospital B and E with a score (4/6.5), while the worst score was for hospital A with a score (1/6.5) (Table 6).

Table 6: Evaluation of color coding, labelling and posters practices.

Score / Color Coding, Labelling and Posters	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
HCF uses a system of color-coding for different types of wastes.	N	Y	Y	Y	Y
Colors of the waste containers are consistent with the color coding	N	N	N	N	N
Infectious waste bags are colored or labeled in accordance with the policies or regulations.	Y	Y	Y	Y	Y
Posters or signs showing proper segregation of healthcare waste.	N	N	Y	Y	N
Total	1	4	4.5	4.5	4

3.7 Transport and Storage

Waste was not transported away from patient areas and other clean areas in the five hospitals. However, all of them transported the waste in a closed, wheeled transport cart. The results showed that apart from hospitals B and C, others cleaned the transport cart at least once a day. The storage area met the proper requirements, kept clean and removed the wastes before the maximum allowable storage time is exceeded in hospitals A, B, D and E except C. Based on the I-RAT, Hospitals A, D and E got the best scores (4/4.5) followed by hospital B with score (3.5/4.5), while the worst score was for hospital C with a score (1/4.5) (Table 7).

Table 7: Evaluation of transport and storage practices

Transport and Storage / Score	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
Waste is transported away from patient areas and other clean areas.	N	N	N	N	N
Waste is transported in a closed (covered), wheeled transport cart.	Y	Y	Y	Y	Y
Transport cart is cleaned at least once a day.	Y	N	N	Y	Y
Storage area meets the proper requirements.	Y	Y	N	Y	Y
Storage area is kept clean.	Y	Y	N	Y	Y
Wastes are removed before the maximum allowable storage time is exceeded.	Y	Y	N	Y	Y
Total	4	3.5	1	4	4

3.8 Hazardous Chemical, Pharmaceutical and Radioactive Waste

Hazardous chemical, pharmaceutical and radioactive wastes were not segregated from infectious and general non-risk wastes in hospitals A, C and D. Only hospital E had a plan for the treatment and disposal of these wastes. Based on the I-RAT, the best score was for hospital E with a score (5/5), followed by hospital B with a score (4/5) while the worst scores were for hospitals A, C and D (0) (Table 8).

Table 8: Evaluation of hazardous chemical, pharmaceutical and radioactive waste practices.

Chemical, Pharmaceutical and Radioactive Waste / Score	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
Hazardous chemical, pharmaceutical, and radioactive wastes are segregated from infectious and general non-risk wastes.	N	Y	N	N	Y
HCF has a plan for treatment and disposal of hazardous chemical, pharmaceutical, and radioactive wastes.	N	N	N	N	Y
Total	0	4	0	0	5

3.9 Treatment and Disposal

All hospitals treated their infectious waste at an off-site treatment facility. However, none of the hospitals treated the laboratory cultures within HCF, and there was no contingency plan for treatment of infectious waste. On the other hand, the transport vehicle met the regulations or international standards in all hospitals. The five hospitals kept copies of manifests or shipment records. However, none of the hospitals had a representative of the HCF inspected the off- site treatment center. Only facility D mentioned that the off-site treatment center used non- incineration treatment technology (Autoclaving) while the others mentioned (Incineration) and none of the hospitals knew where the treated waste or incinerator ashes are dumped. Hospitals A, B, D and E transported their infectious waste to Arcenciel that is located in Beirut while facility C transported their infectious waste to Safe in Abbasiya knowing that both Arcenciel and Safe are companies that treat infectious wastes. Based on I-RAT, Facility D got the best score (36/47.5) while the other hospitals A, B, C, and E got the same score (29/47.5) (Table 9).

Table 9: Evaluation of treatment and disposal practices.

Score / Treatment and Disposal	Hospital (A)	Hospital (B)	Hospital (C)	Hospital (D)	Hospital (E)
HCF treats its infectious waste (either on-site or at an off-site treatment facility) before final disposal	Y	Y	Y	Y	Y
Laboratory cultures and stocks of infectious agents are treated within HCF before being taken away from the facility.	N	N	N	N	N
Contingency plan for treatment of infectious waste in the event that the treatment technology is shut down for repair.	N	N	N	N	N
Transport vehicle meets the regulations or international standards.	Y	Y	Y	Y	Y
Facility keeps copies of manifests or shipment records.	Y	Y	Y	Y	Y
A representative of the healthcare facility has inspected the off-site treatment center.	N	N	N	N	N
Off-site treatment center uses an approved non-incineration treatment technology such as an autoclave-shredder, integrated stream treatment system, or microwave unit.	N	N	N	Y	N
Off-site treatment center uses an incinerator that international standards.	N	N	N	N	N
Facility knows where the treated waste or incinerator ash is dumped.	N	N	N	N	N
Total	29	29	29	36	29

3.10 Overall

Hospital E got the highest score of (104) with a (75%) percentage, followed by hospital D with (97) score and (70%) as a percentage, then hospital A with (89) score and (64%) percentage, hospital C next achieving (86) score and (62%), finally hospital B getting the lowest score of (81) and (58%) percentage. The five evaluated hospitals were within the good outcome (Table 10).

Table 10: Comparative evaluation of healthcare waste management practices

Results / Hospitals	Maximum Score	Score	Percentage Score	Outcome of Study
A	138.5	89	64%	Good
B	138.5	81	58%	Good
C	138.5	86	62%	Good
D	138.5	97	70%	Good
E	138.5	104	75%	Good

4. DISCUSSION

Healthcare waste management (HCWM) is currently a global concern for public health and environment, especially in developing countries (Yazie *et al.,* 2019). The present research study aimed to assess the level of HCWM in hospitals of South Lebanon.

The I-RAT showed that the scores of organization, policy and planning section for the five evaluated hospitals were good. This part of the study is a key factor for waste management system and can affect the performance of the entire process (Joshi et al., 2017). The best scores for hospitals C and E indicated that both had a serious attention to waste management system.

The majority of hospitals had documented policies and strategies regarding HCWM and other safety issues that were based on international and local guidelines such as: Centers for Disease Control and Prevention (CDC), WHO and Lebanese Environmental Ministry. These results are inconsistent with the findings of another study that was done in two hospitals in south west Nigeria (Idowu *et al.,* 2013). The main weak point appeared in hospitals A and B was the absence of permanent committee. In addition, there was lack of waste minimization concept in the evaluated hospitals knowing that hospital E was planning to use electronic health records in future instead of papers. These results were similar to the study done in Nepal (Sapkota et al., 2014).

With respect to training and occupational health and safety, training program was done in the five hospitals about NSI and HCWM but without shedding the light on treatment and disposal parts. The importance of training sessions is defined by their major impact on raising the level of knowledge for healthcare staff (Ozder *et al.,* 2013). Hospital E achieved the best score in which it was the only hospital that gave tetanus vaccination for the staff. In comparison with other reports, our coverage to tetanus vaccination was much lower than a study done in Shiraz city of Iran (Lakbala & Mahesh, 2011). This may be as a result of not mentioning it as one of the mandatory measures in most hospitals, which in turn is linked to the lack of sufficient knowledge about the mode of transmission and the serious complications of tetanus. However, the coverage to hepatitis B vaccination among healthcare personnel was high which is similar to the results of study done in Oman (Al Awaidy *et al.,* 2018). This high rate could be due to the constant spotlight through educational sessions about the importance of hepatitis B vaccine as one of the protective measures that protect the staff from this contagious disease. Proper PPE for workers were absent in the five hospitals, this is in agreement with other study conducted in Dhaka, Bangladesh which considered it as one of the important obstacles that raises the vulnerability to infectious diseases (Sarker *et al.,* 2014).

Also, this is inconsistent with WHO measures that recommend the use of thick gloves, boots, and aprons (Awodele *et al.,* 2016). The reasons of failure to PPE compliance may be because they are not available in hospitals or gaps in knowledge exist about the importance of PPE in preventing the transmission of infections.

Implementing a correct monitoring and compliance plan could permit better management of HCW (Awodele *et al.,* 2016). The scores of I-RAT within this section were disparate among hospitals. Monitoring and implementing corrective acts were common practices in the evaluated hospitals for determining the adherence to HCWM regulations. On the other hand, Sapkota, Gupta and Mainali (2014) reported the absence of these actions in hospital of Nepal. Regarding financing, the majority of hospitals didn't have an adequate budget for HCWM requirements. This is consistent with a couple of previous studies that showed the absence of defined budget for the management of HCW (Lakbala & Mahesh, 2011) (Awodele *et al.,* 2016). The lack of financing services is considered one of the important barriers that prevents achieving a proper HCWM.

Source of waste generation, classification, quantity and quality are crucial issues in deciding how to effectively manage medical waste (Awodele *et al.,* 2016). The scores in this section were undesirable and disappointing. Consistent with other reports, although some hospitals made schematic presentations for the total amounts of waste produced every month, no data were obtained for the daily generation rate (Khan *et al.,* 2019). Unfortunately, the status of segregation was unsatisfactory in the five hospitals. These results were supported by similar studies done in Bale zone of Ethiopia which showed the same findings and confirmed that weak segregation lead to extra costs and many threats to the nature and human health (Sahiledengle, 2019). Moreover, segregation of hazardous waste at origin has been considered a key to maintaining successful control of medical waste (Awodele *et al.,* 2016). Another defective practice observed in one of the hospitals was sorting the HCW for another time after the segregation had been done at origin. This may be due the lack of knowledge and awareness about the risks of such wastes. With respect to WHO, if a small quantity of hazardous waste is applied to the regular waste throughout the segregation procedure, so that the whole amount of the regular waste could be potentially contaminated by hazardous waste (Yazie *et al.,* 2019).

Injections and hazardous wastes are secure if they do not produce a risk to the patient, the staff or the public (Al Awaidy *et al.,* 2018). In this section of the collection and handling practices, the scores ranged between excellent and unacceptable. Several safety issues have been successful in the five hospitals such as using of secure sharp boxes which are always available, this is in agreement with other studies in Oman (Al Awaidy *et al.,* 2018).

According to WHO, safety boxes guarantee that sharps are installed correctly and that can't be moved outside the box and must be filled three quarters (Awodele *et al.,* 2016). In addition, other successful issues were noticed in hospitals like the usage of good quality plastic bags for infectious wastes, and removing the wastes three times a day. Opposite findings regarding these practices have been reported in Nepal (Sapkota et al., 2014). With respect to recapping, although needles had been recapped in the majority of hospitals , their rate was low similar to the findings of other study (Al Awaidy *et al.,* 2018). This showed the increased level of awareness among healthcare personnel about the risk of recapping in transmitting blood-borne pathogens.

Color coding is accomplished by using marked containers or colored ones to distinguish hazardous waste effectively from regular waste (Awodele *et al.,* 2016). The scores of color-coding, labelling and posters were closed between hospitals except for hospital A. Following color coding bags was relevant in the majority of hospitals that facilitate the process of identification and disposal of wastes. However, hospital A was limited to using black bags for regular wastes and yellow bags for infectious wastes which is a bad indicator for waste segregation and categorization. Contrary to these findings were reported in Nepal (Sapkota et al., 2014). The majority of hospitals didn't have posters or representations of the way of segregation into suitable color coding containers which is similar to the findings of other study (Idowu *et al.,* 2013). Knowing that using posters can play a major role in facilitating the process of segregation among healthcare personnel.

The next stage following the segregation of HCW is to transfer waste bins or bags to a temporary storage room (Khan *et al.,* 2019). In this part, the scores were at an acceptable level except for hospital C. The collected waste was moved to the allocated storage room using a closed cart with wheels in the five hospitals. This is against the results of another study that was done in Nepal (Sapkota et al., 2014). No separate path was observed for the transportation of waste. The storage room met some of the requirements such as cleaning and the storage time for infectious wastes in the majority of hospitals. Only in one of the hospitals spillage of infectious wastes were observed outside the storage area which needs an urgent assessment to avoid the disastrous effects. These results are supported by the findings of another study that was done in Shiraz city of Iran (Lakbala & Mahesh, 2011). The duration of storage must not exceed the admissible time and appropriate bio-hazard marks should be available to prevent accidents(Khan *et al.,* 2019).

Regarding hazardous chemical, pharmaceutical and radioactive wastes, the majority of scores in this section was very bad. Hazardous chemical and pharmaceutical wastes were mixed in the storage room for many years without having a plan for treatment. This is consistent with a study done in Bujumbura, Burundi (Niyongabo et al., 2018). Only hospital E sent such wastes into a company for treatment in Switzerland. This may be due to the absence of suitable institutions in Lebanon. Hazardous waste must not be remained for a prolonged period (Khan *et al.,* 2019). Before disposal, hazardous pharmaceutical waste must be returned to its producers for secure treatment, and radioactive wastes should always be packed in secure boxes and sent for treatment to the relevant government institutions (Khan *et al.,* 2019).

The treatment of HCW results in the reduction of volume, mass and infections associated with these wastes (Awodele *et al.,* 2016). There was absence of on-site treatment facilities in the evaluated hospitals in which they transported their wastes to off-site treatment centers. Similarly, Awodele, Adewoye and Oparah (2016) reported that waste treatment was not popular in hospitals of Lagos. Unfortunately, there was inadequate knowledge about the accurate method of treatment and the final disposal of HCW used by the on-site treatment centers. This is a bad indicator for not following the process of HCWM till the end. Regular wastes were transported by municipals to dumping areas.

The overall score of the five evaluated hospitals was within the good outcome in which hospital E achieved the highest score (104), followed by hospitals D, A, C then B with scores (97), (89), (86) and (81). These results are much higher than the findings obtained from the evaluation done in Nepal, by filling the same IRAT questionnaire ,where the final score was within the poor outcome with a score (36) (Sapkota et al., 2014). This big difference in scores between Lebanon and Nepal can be explained by the weakness of medical system in Nepal. Health care facilities in Nepal lack services, human resources (doctors, nurses, and technical staff) and necessary medications. This in turn demonstrates the low financial capacity and the absence of knowledge about infection control measures in different health aspects. On the other hand, Lebanon have competent and experienced staff who in turn work to raise the level of health by focusing more on infection measures and strategies.

Although the scores of I-RAT were in the good category, a breakage in the waste management chain was observed in many sides of the whole process in Lebanese hospitals. This imbalance in many practices of waste management could be due to many reasons related to financial issues, knowledge or even the mentality of personnel. Also, the most important reason to highlight in this study is the absence of an adequate monitoring and accountability by the relevant ministries which negatively affects how the process works. The same applies to the Lebanese nature, which is experiencing a high pollution rate in the absence of accountability and strict legislations. Hence, Lebanese hospitals should concentrate more on HCWM and improve policies and practices to address this important issue since improper management of HCW can lead to an increase in the nosocomial infections risks.

5. LIMITATIONS

Only few hospitals were enrolled in this study which prevents to generalize the findings to all hospitals in South Lebanon. Also, the study was restricted to only one visit to each hospital. In addition, one hospital refused to make a direct observation in the floors and thus we had filled out these parts of the questionnaire with the help of infection control manager of that hospital.

6. CONCLUSION

A. The present study showed that hospitals in South Lebanon had taken the essential step in trying to improve HCWM process.
B. In majority of hospitals, HCW were collected and separated into color coding containers and then transported to the temporary storage area within the facilities and at the end moved to the off- site treatment center.
C. However, unsatisfactory practices were common in hospitals regarding policies, regulations, procedures, safety issues and awareness that need to be monitored.
D. Additional focus is needed to enhance the entire process of waste management and thus to avoid the health and environmental hazards associated with these hazardous wastes.

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