

EVALUATION OF OCCUPATIONAL SAFETY AND WASTE MANAGEMENT PRACTICES IN THE MAIN HOSPITALS IN BENGHAZI CITY

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المخلص

تهدف هذه الدراسة إلى تقييم تطبيقات إدارة النفايات وتقييم السلامة المهنية للطواقم الطبي بالإضافة إلى تقدير تكاليف إدارة النفايات في المستشفيات الرئيسية بمدينة بنغازي. تمت هذه الدراسة خلال الفترة من شهر أبريل 2013 إلى شهر فبراير 2014 وذلك من خلال إجراء مسح ميداني شامل لثلاث مستشفيات وهي الجلاء، الجمهورية والأطفال وذلك من خلال القيام بزيارات ميدانية بالإضافة إلى تعبئة استبيان تم إعداده وتوزيعه على الطاقم الطبي (أطباء - ممرضين - فنيين). الهدف من الدراسة هو جمع معلومات عن مختلف جوانب إدارة النفايات والتي تشمل نوع النفايات التي يتم أنتجها وطرق فصلها وجمعها وعن الصحة والسلامة المهنية للطواقم الطبي والفحص الطبي الذي يجرى لهم بالإضافة إلى التطعيم والتدريب والإصابات التي يتعرضون لها أثناء عملهم. لتحليل البيانات التي تم تجميعها تم استخدام مخطط باريتو (Pareto chart) ومخطط عظم السمكة (fishbone).

أشارت نتائج الدراسة إلى أن فصل النفايات لا يتم بصورة صحيحة حيث أنه أحيانا تخلط النفايات العادية مع الخطرة، مع عدم وجود سجلات تدل على كمية النفايات المنتجة؛ كما يتم توظيف عمال نظافة غير أكفاء، بالإضافة إلى عدم وجود غرف تخزين مؤقتة للنفايات. أما فيما يتعلق بالصحة والسلامة المهنية فقد تبين بأنه لا توجد سياسة واضحة للتطعيم والفحص الطبي وعدم توفير التدريب المستمر واللامبالاة في استعمال معدات الوقاية الشخصية واستخدام معدات وقاية ذات جودة منخفضة، بالإضافة إلى ارتفاع معدل الإصابات بين الطاقم الطبي. كما أشارت نتائج هذه الدراسة إلى أن تكاليف الإدارة الجيدة للنفايات أقل بكثير من تكاليف الإدارة السيئة لها، حيث إن متوسط التكاليف التقديرية للإدارة الجيدة للنفايات حوالي 577339 دينار ليبي لكل سنة في حين أن متوسط التكاليف التقديرية للإدارة السيئة للنفايات حوالي 1850585 دينار ليبي لكل سنة.

ABSTRACT

This study is aimed to examine the waste management practices, occupational safety among medical staff and estimation of waste management costs in the largest three hospitals in Benghazi city during the period from April 2013 to February 2014. A comprehensive survey was conducted for the three hospitals (Aljalaa, Alathfal, Aljmehoria). Sites visits and a questionnaire survey method were implemented to collect information regarding different waste management aspects, including generation, segregation and collection of waste, health and occupational safety, medical examination and vaccination, injuries and training. A questionnaire has been developed for medical staff (doctors, nurses, technicians). Analysis of data was performed by the use of statistical package of social science (SPSS), Pareto chart is also used to identify and prioritize problem areas, and reverse fishbone diagram is used to evaluate and choose of the solutions.

The results of this study revealed that, there was insufficient separation between hazardous and general waste, failure to quantify the waste generated in reliable records, use some of unqualified cleaning workers and there are no temporary storage areas. There was no clear policy for vaccination and medical examination, lack of training, lack of wearing of personal protective equipment during work, lack of proper personal protective equipment and a high rate of injuries among medical staff. This study indicates that, good waste management costs are less than poor waste management costs where on average estimated costs of good waste management are 577339 L.D/year while the average estimated costs of poor waste management are 1850585 L.D/year.

KEYWORDS: Waste Management; Medical Waste; Occupational Safety; Hazardous and General Waste; Reverse Fishbone.

INTRODUCTION

Very broadly, medical waste is defined as any solid or liquid waste that is generated in the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biological [1]. Over the past two decades, medical waste has been identified as one of the major problems that negatively impact both human health and the environment when improperly stored, transported and disposal [2]. In Libya, as in many developing countries, little information is available regarding generation, handling and disposal of hospital waste. This fact hinders the development and implementation of hospital waste management schemes. Hospital waste management and the associated pollution problems have attracted significant attention but very few studies on hospital waste have been conducted in Libya [3]. Alhain and Ifhima [4] covered four case studies by selecting the largest four hospitals located in the eastern part of Libya. The data have been collected by using special questionnaire, personal observation, and interviews. The main results of the study indicate that all the selected hospitals have poor skills about medical waste management. Almegreisi and Algwail [5], covered five hospitals located in Benghazi, field visits were conducted to provide information on the different medical waste management aspects. The study showed that nearly all hospitals have poor medical waste management.

Sawalem and Herbell [6] conducted a research in the form of a case study in fourteen different healthcare facilities in three cities, Tripoli, Misurata and Sirt. The research showed that, insufficient segregation, classification and treatment of waste were noted at all the surveyed hospitals. The study reveals a serious need to establish and implement a proper medical waste management strategy to control and improve the current situation in the surveyed hospitals.

Calin Georgescu [7], carried out a survey of 300 medical waste handlers employed by a local contractor in Tripoli, The survey showed that prevalence rates of hepatitis B and C were significantly higher in medical waste handlers than those in non-medical waste handlers examined.

DATA COLLECTION AND ANALYSIS

This study was carried out in the three hospitals in Benghazi city (Aljalaa hospital, Alathefal hospital, and Aljmehoria hospital). The main tools used in data collection were questionnaires, interviews, visiting, and personal observation. To support and supplement information collected in visits, interviews were conducted with the head of infection control office, the personnel in the management and with the personnel involved in collection, handling, and disposal of waste in each hospital.

The questionnaire has been developed for medical staff (doctors, nurses, and technicians), consisting of eight parts for focusing and gathering information mainly at several issues as medical staff training and evaluate the consistent use of personal protection equipment, accident among medical staff, as well as generation, segregation, and collection of waste.

According to Pallant [8], Alpha Coefficient of (≥ 0.70) is considered adequate for the reliability of the entire questionnaire. A reliability test was conducted for the developed questionnaire before its final distribution, the calculated value of Cronbach's Alpha was found to be (0.794) which gives strong evidence that the questionnaire responses were reliable.

The study population consists of doctors, nurses, and technicians at surveyed hospitals; total number of study population is 2200. According to table of Krejcie and Morgan [9], the sample size is 327. Table (1) shows sampling size of the survey, 400 hard copies were distributed to various departments in each hospital. Out of 400 copies sent, 327 copies were returned with the full-completed questionnaires, giving a response rate of 81.75%.

Table 1: Sampling size of the survey

No	Item	Hospitals			Total
		Aljalaa Hospital	Alatefal Hospital	Algmehoria Hospital	
1	Number of doctors	250	341	323	914
2	Number of nurses	264	352	243	859
3	Number of technicians	163	156	108	427
4	Total	677	849	674	2200
5	Percent	30.77%	38.59%	30.64%	100%
6	Sample size	327 (from table of Krejcie and Morgan)			
7	Sample of doctors	37	51	48	136
8	Sample of nurses	40	52	36	128
9	Sample of technicians	24	23	16	63
10	Sample by hospital	101	126	100	327

Analysis of data was performed by the use of Statistical Package of Social Science (SPSS), Pareto Chart is used to identify and prioritize problem areas, and Reverse Fishbone Diagram is used to evaluate and choose of the solutions.

WASTE MANAGEMENT PRACTICES

Production of waste

The results of answers on the questions related to the production of the wastes are shown in Table (2). It was difficult to know the actual amount of waste generated in the surveyed hospitals because none of those hospitals weigh and keep record of the waste generated.

Table 2: Production of the wastes in the surveyed hospitals

Subject	Answers						Total	
	Always		Sometimes		No		Freq.	%
	Freq.	%	Freq.	%	Freq.	%		
The hospital produce infectious waste	179	54.7	69	21.1	79	24.2	327	100
The hospital produce pathological waste	147	45.0	65	19.9	115	35.2	327	100
The hospital produce sharp waste	231	70.6	40	12.2	56	17.1	327	100
The hospital produce pharmaceutical waste	182	55.7	72	22.0	73	22.3	327	100
The hospital produce heavy metal waste	149	45.6	105	32.1	73	22.3	327	100
The hospital produce chemical waste	140	42.85	118	36.1	69	21.2	327	100
The hospital produce general waste	214	65.4	57	17.4	56	17.1	327	100

Separation of waste

From observations during fieldwork, Aljalaa and Alathefal hospitals separate hazardous waste from general waste stream by medical staff at the waste production points. However, separation of waste is not conducted according to definite rules and standards, do not label hazardous waste with biohazard symbol, sometimes, hazardous waste is mixed with general waste in the bags, and syringes are put with needles in safety boxes, for this reason safety boxes are filled quickly. In Aljmehoria hospital, there is no segregation of waste except for sharp waste. Sharp waste is collected in safety boxes, and other waste is packaged in black bags. Table (3) gives an idea about the results related to separation of waste. Figure (1) shows Pareto chart of waste separation problems.

Table 3: Frequency and percentages for answers on questions related to separation process

Questions	Answers						Total	
	Always		Sometimes		No		Freq.	%
	Freq.	%	Freq.	%	Freq.	%		
Is hazardous waste separated from general waste?	104	31.8	151	46.2	72	22.0	327	100
Does medical staff separate waste?	64	19.6	116	35.5	147	45.0	327	100
Do cleaning workers separate waste?	92	28.1	116	35.5	119	36.4	327	100
Is waste separated at the beginning near the source?	94	28.7	135	41.3	98	30.0	327	100
Is each type of waste clearly identified by a color code or symbol?	114	34.9	105	32.1	108	33.0	327	100

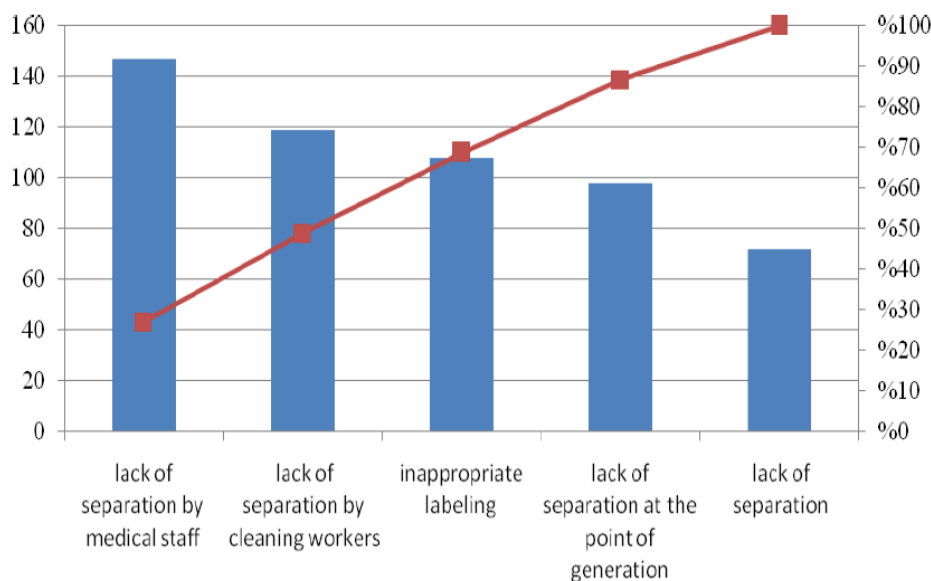


Figure 1: Pareto chart of waste separation problems

Waste segregation is the most important way of minimizing the costs of the treatment and disposal of infectious waste and minimizing the risks to the health and the environment. To evaluate and choose of the solutions reverse fishbone can be used. Figure (2) shows proposed solution to reach to the full separation of waste.

From Figure (2), it can be concluded that, the proposed solution include that, all waste should be separated by the medical staff into four categories, general waste, infectious and pathological waste, chemical and pharmaceutical waste, and used sharps.

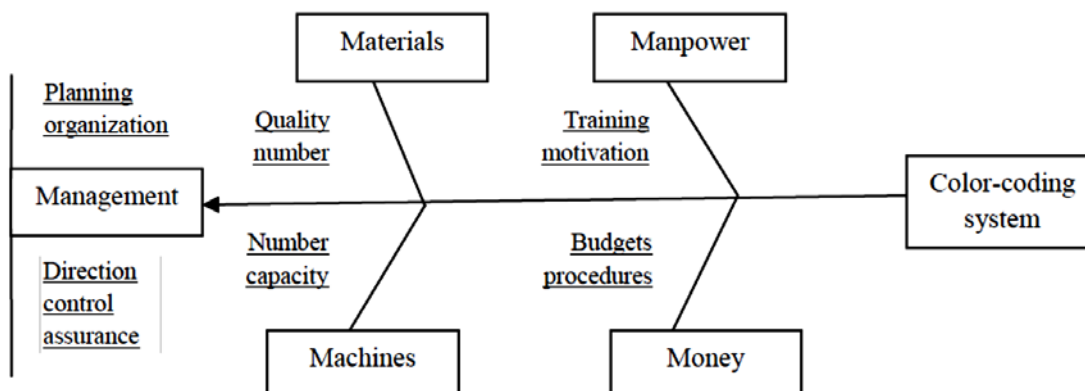


Figure 2: Reverse fishbone to proposed solution to reach to the full separation of waste

Collection of waste

During the site visits, it was noted that, the three hospitals depended on private cleaning companies for collecting waste. These same companies were the ones responsible of supervising cleaning workers, thus making the process susceptible to weaknesses aggravated by lack of adequate monitoring performed by the surveyed hospitals. None of the private cleaning companies had special worker for collecting waste since workers were responsible of collecting all types of waste in addition to all other cleaning tasks. Therefore, workers were not giving much care to the nature and types of waste they were collecting. Cleaning workers do not receive any information on the occupational risks to which they are exposed and on the correct procedures for handling, loading and unloading of waste bags and containers. They are often poorly educated, and often do not receive any vaccinations, or proper personal protective equipment. Table (4) presents the answers on questions related to waste collection. Fig. 3 shows Pareto chart of waste collection problems.

Table 4: Frequency and percentages for answers on questions related to waste collection

Questions	Answers						Total	
	Always		Sometimes		No			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Are waste bags stayed a long time within the sections?	41	12.5	146	44.6	140	42.8	327	100
Are waste baskets cleaned daily?	55	16.8	146	44.6	126	38.5	327	100
Do the workers in the collection process have an experience in this field?	37	11.3	87	26.6	203	62.1	327	100
Are the number of cleaning workers sufficient?	21	6.4	107	32.7	199	60.9	327	100
Are cleaning workers supervised during waste collection?	32	9.8	89	27.2	206	63.0	327	100
Are waste bags filled overly?	31	9.5	161	49.2	135	41.3	327	100
Are waste bags fastened properly?	99	30.3	160	48.9	68	20.8	327	100
Are waste bags subjected to tear?	104	31.8	149	45.6	74	22.6	327	100
Are there baskets and bags everywhere where waste is generated?	107	32.7	153	46.8	67	20.5	327	100
Are waste bags in a place that can be easily accessed by the patients or visitors?	105	32.1	134	41.0	88	26.9	327	100

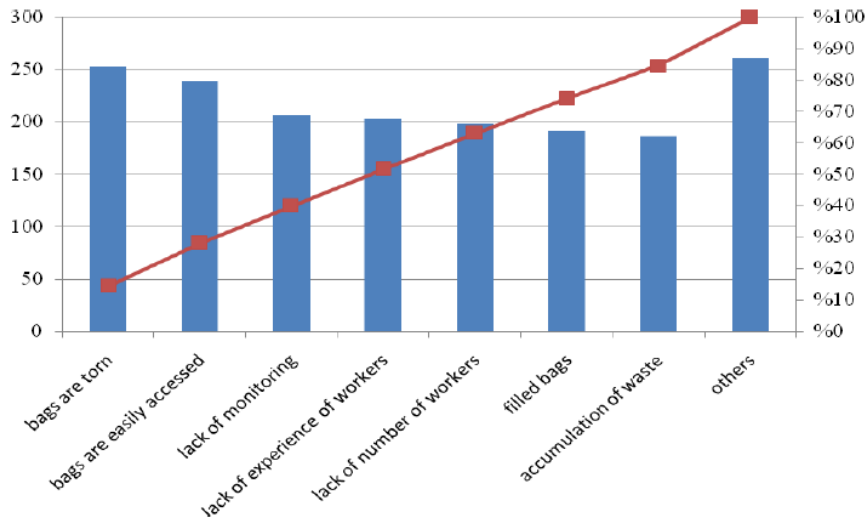


Figure 3: Pareto chart of waste collection problems

From Figure (3), it can be concluded that, the significant few is, bags are torn, bags are easily accessed, lack of monitoring, lack of experience of workers, lack of number of workers, and filled bags. Figure (4) shows proposed solution to reach to proper collection of waste.

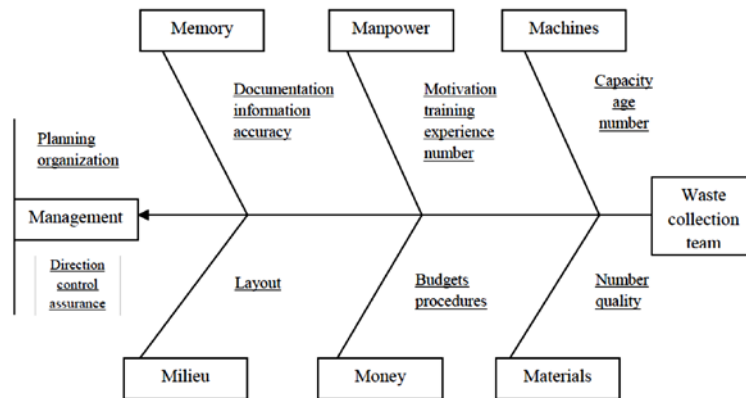


Figure 4: Reverse fishbone to proposed solution to reach to proper collection of waste

From Figure (4), it can be concluded that, the proposed solution include establishment of the waste collection team, a precise schedule for hazardous and general waste collection, at least once a day should be implemented, All waste should be weighed and recorded by the waste collection team in order to know the amount of waste generated per day and allocate adequate budget for waste collection process

Transport of waste inside the hospital

In three hospitals, private company's workers use covered trolleys for on-site transport of waste from the sites of production (different departments) to the temporary storage area. In general, hazardous and general wastes are transported together. Usually, the trolleys are overfilled and left open; these practices were causing bags to drop and to be torn, thus polluting the surrounding and possibly harming workers, patients and visitors. Such risks were increased by practices such as continuous use of waste trolleys without rinsing.

Waste storage

There are no rooms for the storage of waste, whether general or hazardous, but wastes are transferred from within the departments to the containers by trolleys devoted for the transfer of waste. Storage containers are exposed to rain, sun, and winds easy accessible by individuals, insects and birds. All types of waste are mixed together in storage containers.

Transport of waste outside the hospital

The private company's workers are responsible for the off-site transportation of waste to the final disposal site. The frequency of transport varied from one time to three times a day. Hazardous and general waste is transported together. In general, open vehicles and in some cases, closed vehicles were used for off-site transportation. The open vehicles passed through residential areas, thereby increasing potential risk to the public and the environment.

Treatment and final disposal of waste

There is no special treatment to get rid of waste within the surveyed hospitals. This is because of the absence of any treatment facility to eliminate the negative effects resulting from this waste.

All untreated wastes from the surveyed hospitals are transported to Qnfohd landfill, which has been dedicated for this purpose by private company's workers. Municipal workers do the final disposal of the waste.

Plan of waste management

There is no clear policy and plan in place for managing waste at the surveyed hospitals. The surveyed hospitals have a waste management guideline prepared by the head of infection control but this is not strictly followed.

HEALTH AND OCCUPATIONAL SAFETY PRACTICES

In the second part of the questionnaire, as seen in tables (5) through (10), the questions focus on the health and occupational safety of the medical staff in the surveyed hospitals.

Table 5: Frequency and percentages of answers on questions related to wearing personal protective equipment

Questions	Answers						Total	
	Always		Sometimes		No			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Is your work need personal protective equipment?	160	48.9	135	41.3	32	9.8	327	100
Do you wear special shoe during work?	112	34.3	103	31.5	32	9.8	327	100
Do you wear goggles during work?	-	-	22	6.7	305	93.3	327	100
Do you wear facemask during work?	51	15.6	142	43.4	134	41.0	327	100
Do you wear hair cover during work?	49	15.0	61	18.7	217	66.4	327	100
Do you wear gloves during work?	155	47.4	130	39.8	42	12.8	327	100
Do you use same gloves more than once?	14	4.3	53	16.2	260	79.5	327	100
Does the hospital provide P.P.E?	62	19.0	147	45.0	118	36.1	327	100
Is this equipment preventive?	29	8.9	126	38.5	172	52.6	327	100
Does the hospital monitor usage of P.P.E?	13	4.0	68	20.8	246	75.2	327	100
Does the hospital punish employees who do not wear P.P.E?	10	3.1	43	13.1	274	83.8	327	100

Table 6: Results on questions related to testing and vaccinating

Questions	Answers				Total	
	Yes		No			
	Freq.	%	Freq.	%	Freq.	%
Have you been tested before you were employed?	217	66.4	110	33.6	327	100
Have you been tested after you were employed?	35	10.7	292	89.3	327	100
Are you vaccinated against hepatitis?	245	74.9	82	25.1	327	100
Have you been give vaccinations to prevent specific diseases?	71	21.7	256	78.3	327	100

Table 7: Frequency and percentages for answers on questions related to the training

Questions	Answers				Total	
	Yes		No			
	Freq.	%	Freq.	%	Freq.	%
Have you been trained on waste management?	82	25.1	245	74.9	327	100
Do you aware about the hazard of some of waste after you were trained?	94	28.1	233	71.3	327	100
Can you deal with waste after you were trained?	97	29.7	230	70.3	327	100

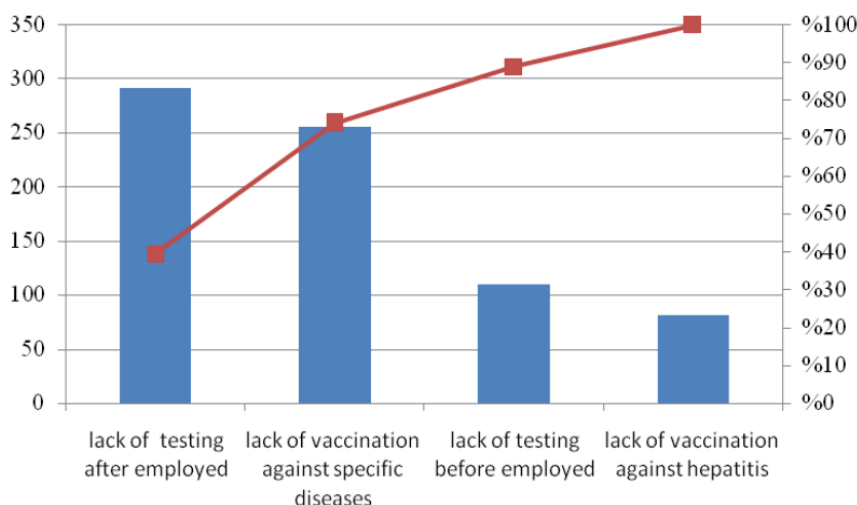


Figure 5: Pareto chart of testing and vaccinating problems

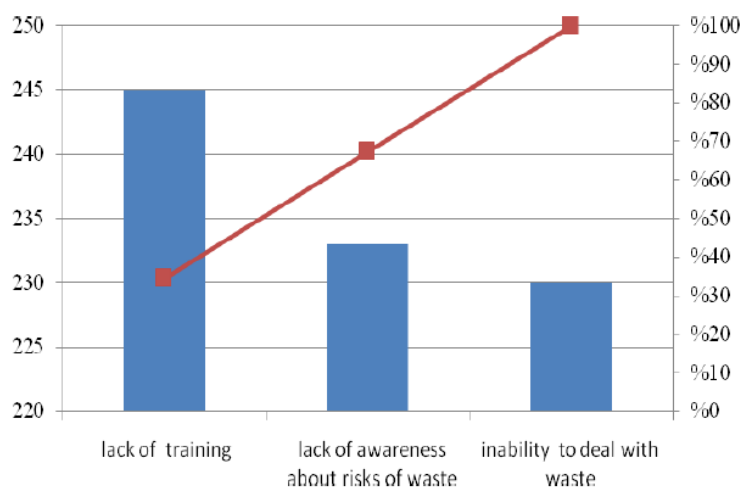


Figure 6: Pareto chart of the training problems

Table 8: Frequency and percentages for answers on questions related to types of injuries

Questions	Answers						Total	
	Always		Sometimes		No			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Have you been subjected to needle stick during work?	31	9.5	181	55.4	115	35.2	327	100
Have you been subjected to cut any sharp tool during work?	16	4.9	120	36.7	191	58.4	327	100
Were you injured skin diseases during work?	15	4.6	55	16.8	257	78.6	327	100
Were you injured fractures or bruises during work?	6	1.8	40	12.2	281	85.9	327	100
Were you injured respiratory diseases during work?	27	8.3	76	23.2	224	68.5	327	100
Were you injured intestinal diseases during work?	16	4.9	99	30.3	212	64.8	327	100
Were you injured burns during work?	2	0.6	13	4.0	312	95.4	327	100
Were you injured any type of bacteria or viruses blood during work?	4	1.2	46	14.1	277	84.7	327	100

Table 9: Results on questions related to causes of injury

Questions	Answers						Total	
	Always		Sometimes		No			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Did you hit because of overwork?	13	4.0	47	14.4	267	81.7	327	100
Did you hit because of lack of patient cooperation?	12	3.7	86	26.3	229	70.0	327	100
Are you injured while surgical operations?	5	1.5	44	13.5	278	85.0	327	100
Are you injured while remove needle's cover?	8	2.4	111	33.9	208	63.6	327	100
Are you injured while recover the needle?	9	2.8	117	35.8	201	61.5	327	100
Are you injured while disposal of needle?	6	1.8	66	20.2	255	78.0	327	100
Did you hit because of contact with contaminated materials?	11	3.4	59	18.0	257	78.6	327	100
Did you hit because of stress and fatigue at work?	40	12.2	123	37.6	164	50.2	327	100
Did you hit because of spill liquids on the ground or the body?	17	5.2	58	17.7	252	77.1	327	100

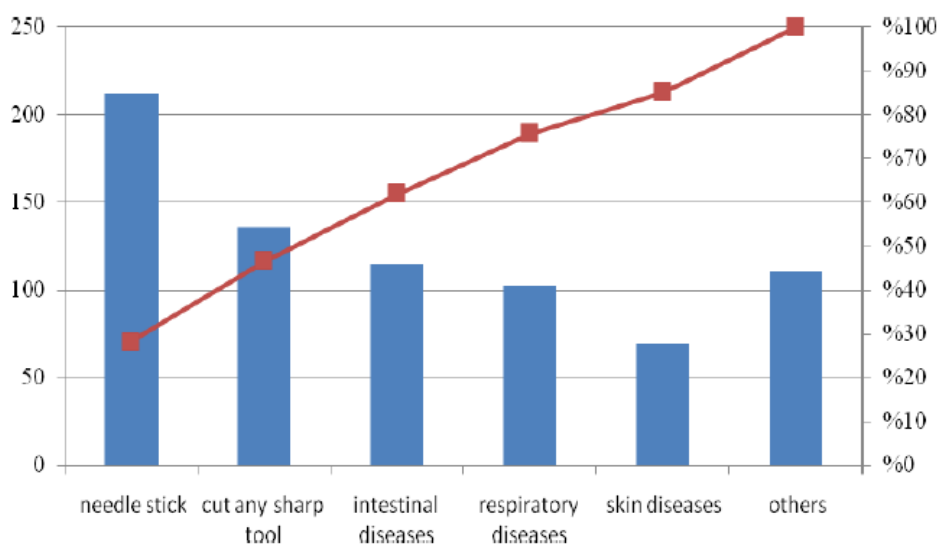


Figure 7: Pareto chart of the injuries problems

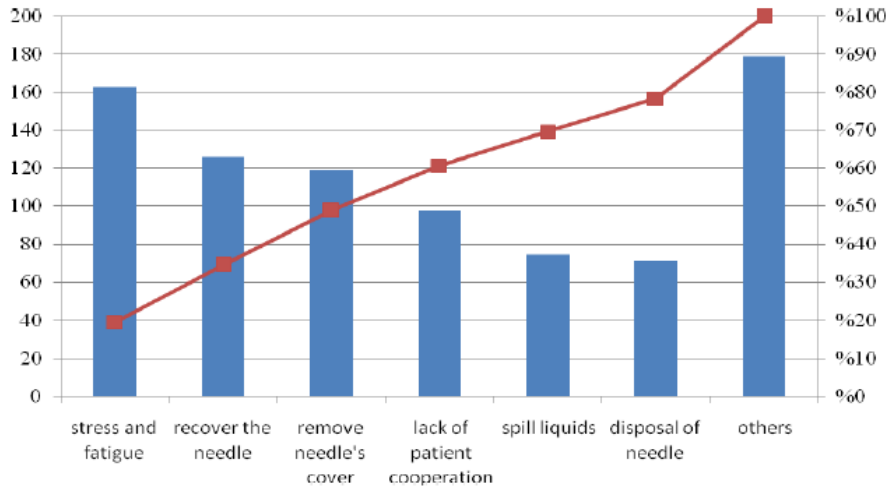


Figure 8: Pareto chart of causes of injury

Table 10: Results on questions related to procedures after the injury

Questions	Answers						Total	
	Always		Sometimes		No			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Do you report about the injury?	26	8.0	37	11.3	264	80.7	327	100
Have you been investigated for injury?	9	2.8	12	3.7	306	93.6	327	100
Have you been tested?	5	1.5	11	3.4	311	95.1	327	100
Have you been treated at hospital's expense?	2	0.6	5	1.5	320	97.9	327	100
Were you given a sick leave?	8	2.4	73	22.3	246	75.2	327	100
Were you given compensation?	2	0.6	4	1.2	321	98.2	327	100

Figure (9) shows proposed solution to improvement of occupational safety and reducing of the injuries.

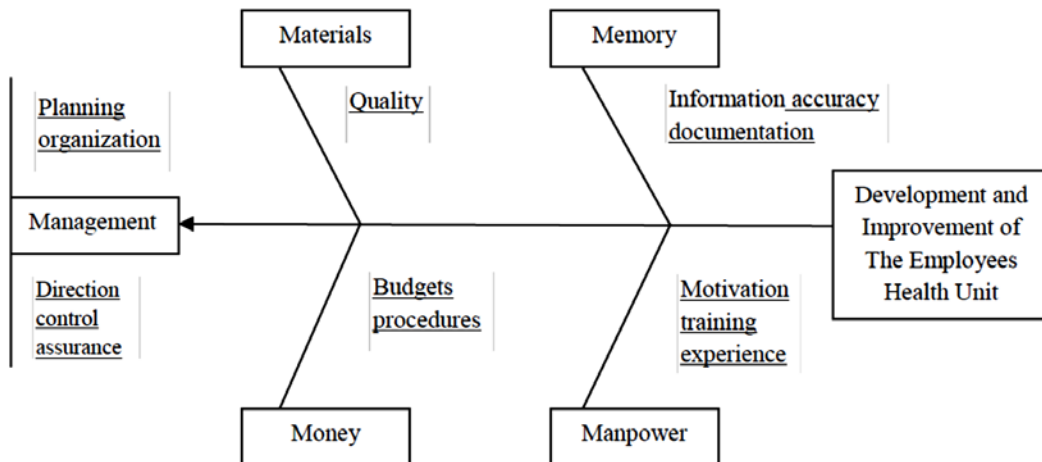


Figure 9: Reverse fishbone to proposed solution to improvement of occupational safety and reducing of the injuries

From Figure (9), it can be concluded that, the proposed solution include, development and improvement of the employees' health unit, medical examination and vaccination of the employees against infectious diseases should be routine, and provision of personal protective equipment of acceptable quality and sufficient number.

QUANTITY OF GENERATED WASTE IN THE SURVEYED HOSPITALS

Estimate quantity of generated waste in each hospital as follows [10].

$$GW = -15.76 + 1.21(PAT) + 0.714(BED) + 10.74(TYPE)$$

Where:

GW - is quantity of generated waste (kg / day).

PAT - is number of patients.

BED - is number of beds.

TYPE - is type of hospitals (0 for private and 1 for public and teaching hospitals).

According to WHO, 80% of all waste generated at health care facilities is general waste, 15% pathological and infectious waste, 1% sharps waste, 3% chemical or pharmaceutical waste, and less than 1% special waste [11]. Table (11) shows quantity of generated waste in the surveyed hospitals. In order to compute volume of the waste, assuming that an average waste density of 150 kg / m³ [10]. Table (12) shows waste volume in the surveyed hospitals. Each country has different ranges of medical waste production depending upon its medical situations [12].

Table 11: Quantity of generated waste in the surveyed hospitals

No	Generation Rate	Aljalaa hospital	Alathefal hospital	Aljmehoria hospital
1	Generation rate (kg / patient / day)	3.08	1.93	2.52
2	Generated general waste (kg / day)	434.245	525.992	650.4
3	Generated hazardous waste (kg / day)	103.133	124.923	154.47
4	Generated sharps waste (kg / day)	5.428	6.575	8.13
5	Total generated waste (kg / day)	542.806	657.49	813

Table 12: Volume of waste in the surveyed hospitals

No	Volume of Waste	Aljalaa hospital	Alathefal hospital	Aljmehoria hospital
1	Hazardous waste volume (liter / day)	687.553	832.82	1029.8
2	General waste volume (liter / day)	2894.967	3506.613	4336
3	Sharps waste volume (liter / day)	36.187	43.833	54.2
4	Total waste volume (liter / day)	3618.707	4383.267	5420

COSTS ASSOCIATED WITH GOOD MANAGEMENT OF WASTE

All activities and equipment related to health care waste management should be included in the cost analysis. They comprise direct costs of supplies and materials used for collection, transport, storage, treatment, disposal, decontamination and cleaning. As well as the cost of labor and material for training and maintenance costs. These costs will vary depending on the treatment method chosen.

Tables (13) through (15) summarize good management costs of waste in the surveyed hospitals.

Table 13: Separation and collection costs

No	Item	Hospitals	Annual estimated quantity (number)	Estimated unit cost (L. D)	Annual estimated cost (L. D / year)
1	Colored plastic bags (yellow, brown, and black), capacity 12 liter.	Aljalaa	145291	0.4	58116
		Alathefal	175988	0.4	70395
		Aljmehoria	217613	0.4	87045
2	Safety boxes for sharps waste, capacity 3 liter.	Aljalaa	4403	1.50	6605
		Alathefal	5333	1.50	8000
		Aljmehoria	6594	1.50	9891
3	Weighing machines for weighing waste bags.	Aljalaa	1	150	150
		Alathefal	1	150	150
		Aljmehoria	1	150	150
4	Bag holders to be located at all sources of waste in hospital, capacity 12 liter.	Aljalaa	398	6.25	2488
		Alathefal	482	6.25	3013
		Aljmehoria	596	6.25	3725
5	Trolleys for transporting the waste to temporary storage place, capacity 120 liter.	Aljalaa	40	25	1000
		Alathefal	49	25	1225
		Aljmehoria	60	25	1500
6	Cleaning workers salaries.	Aljalaa	-	-	356760
		Alathefal	-	-	187200
		Aljmehoria	-	-	574800
7	Protective clothing for cleaning workers.	Aljalaa	-	-	6506
		Alathefal	-	-	3665
		Aljmehoria	-	-	11911
8	Training for cleaning workers.	Aljalaa	-	-	35500
		Alathefal	-	-	20000
		Aljmehoria	-	-	65000
9	Disinfection solution.	Aljalaa	-	-	10000
		Alathefal	-	-	10000
		Aljmehoria	-	-	10000
10	Total estimated cost (L. D / year)	Aljalaa		477125	
		Alathefal		303648	
		Aljmehoria		764022	

Table 14: Storage and transport costs

A- Capital costs				
No	Item	Hospitals	Capital cost (L. D)	Annual estimated cost (L. D / year)
1	Temporary central storage room (to keep all categories of waste after segregation before disposal), (r = 1%, t = 15 years)	Aljalaa	10000	721
		Alathefal	10000	721
		Aljmehoria	10000	721
2	Ventilators for storage room, (r = 1%, t = 5 years)	Aljalaa	1575	325
		Alathefal	1575	325
		Aljmehoria	1575	325
3	Transport vehicle, (r = 1%, t = 10 years)	Aljalaa	92500	9765
		Alathefal	92500	9765
		Aljmehoria	92500	9765
B- Recurrent Costs				

No	Item	Hospitals	Annual estimated quantity (number)	Estimated unit cost (L. D)	Annual estimated cost (L. D / year)
1	Containers for storage, capacity 1100 liter	Aljalaa	5	200	1000
		Alathefal	6	200	1200
		Aljmehoria	7	200	1400
2	Fuel used by the vehicle	Aljalaa	-	-	150
		Alathefal	-	-	150
		Aljmehoria	-	-	150
3	Maintenance of vehicle (20% of capital cost)	Aljalaa	-	-	18500
		Alathefal	-	-	18500
		Aljmehoria	-	-	18500
4	Transport-labor salaries	Aljalaa	-	-	9720
		Alathefal	-	-	9720
		Aljmehoria	-	-	9720
5	Protective clothing for cleaning workers	Aljalaa	-	-	275
		Alathefal	-	-	275
		Aljmehoria	-	-	275
6	Total estimated cost (DL / year)	Aljalaa	40456		
		Alathefal	40656		
		Aljmehoria	40856		

COSTS ASSOCIATED WITH POOR MANAGEMENT OF WASTE

Costs of hospital acquired infections

Costs of hospital acquired infections = average number of inpatients in the year × one day × total estimated costs to treat of inpatient in the day [13].

The total estimated costs to treat of inpatient was 81 L.D / day.

Final costs using the previous equation is:-

Costs of hospital acquired infections in Aljalaa hospital = $26645 \times 1 \times 81 = 2158245$ L.D / year.

Costs of hospital acquired infections in Alathefal hospital = $14965 \times 1 \times 81 = 1212165$ L.D / year.

Costs of hospital acquired infections in Aljmehoria hospital = $25915 \times 1 \times 81 = 2099115$ L.D / year.

Table 15: Treatment costs

No	Item	Hospitals	Annual estimated cost (L.D / year)
1	Modern incinerator (r = 1%, t = 10 years)	Aljalaa	7919
		Alathefal	7919
		Aljmehoria	7919
2	Operating cost = 0.05 L.D / kg	Aljalaa	1981
		Alathefal	2400
		Aljmehoria	2967
3	Maintenance of incinerator	Aljalaa	4000
		Alathefal	4000
		Aljmehoria	4000

4	Workers salaries	Aljalaa	7200
		Alathefal	7200
		Aljmehoria	7200
5	Protective clothing for workers	Aljalaa	183
		Alathefal	183
		Aljmehoria	183
6	Total estimated cost	Aljalaa	21283
		Alathefal	21702
		Aljmehoria	22269

Costs of staff injuries

Studies worldwide indicate that needle stick injuries are common among health care workers. Table (16) shows the number and type of injuries among staff in studied hospitals.

Table 16: Number and type of injuries among staff in studied hospitals

No	Hospitals	Type of injury	Number of injury	Cause of injury	Profession	Cost of treatment (DL / year)
1	Aljalaa	Hepatitis	1	needle-stick	technician	19730
2	Alathefal	HIV	1	needle-stick	nurse	62500

COMPARISON OF COSTS OF WASTE MANAGEMENT

Table (17) shows comparison of costs of waste management. The study shows that, poor waste management costs three times more than costs of good waste management.

Table 17: Comparison of costs of waste management

No	Hospitals	Estimated costs of good waste management (DL / year)	Estimated costs of poor waste management (L.D / year)	Percentage
1	Aljalaa	538864	2177975	24.74%
2	Alathefal	366006	1274665	28.71%
3	Aljmehoria	827147	2099115	39.40%
4	Total	1732017	5551755	-

CONCLUSIONS AND RECOMMENDATIONS

The study showed a great defect and clear weakness of safe and effective management for waste at the surveyed hospitals. There were also great defect and lack of technical and financial resources required for operating special management concerning waste, and the urgent need for training workers who are working at the sector of waste management in the surveyed hospitals. During the study, the following notes were recorded about the surveyed hospitals:

- There is no clear policy and plan in place for managing waste.
- Absence of a committee responsible for monitoring waste management practices.
- The private company's workers are responsible for waste collection, do not have proper training and experience, which leads to inappropriate waste management.
- There is no segregation of waste except for sharp waste.

- The bags used are of low thickness so it will be more probable to be subjected to tear and rupture.

The recommendations that can contribute to raising the efficiency of the work of the wastes administration in Libya hospitals in general and Benghazi city hospitals in particular came as a result to the study that shows many disadvantages in management of wastes in surveyed hospitals in Benghazi city.

- Focus on reduction generated hazardous waste.
- Focus on waste segregation.
- Focus on sharp waste management.
- Develop plans and policies for waste management.
- A precise schedule should be implemented at least three times a day for wastes collection, storage, transportation and treatment.
- Ensure employees safety through education, training, immunization and proper personal protective equipment's.
- To urge allocate adequate budget for the management of waste.

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