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Research paper



Evaluation of the Reality of the Management and Treatment of Solid Waste in Al-Yarmouk Teaching Hospital

Ghayda Yaseen AL Kindi [1]*

[1] *Civil Engineering Department, University of Technology, Baghdad, Iraq*
**Corresponding author E-mail: 40126@uotechnology.ed.iq*

Abstract

The aim of this study is to evaluate the reality of the management and treatment of solid waste in Al-Yarmouk teaching hospital, it's observed that total generation rate of solid waste per day was 116.133 kg/day. while the rate of medical waste generation was 55.075 kg/day. More than 50% of this waste was generated in the surgery rooms and patients' rooms. As well as, it was found that the generation rate of waste for each bed per day was (0.87) kg, while it was (0.28 kg/bed.day) of medical solid waste. In addition, the medical wastes characteristics are studied by taking samples during 3 months of 2017, and analyzing them to determine their moisture content and density. The moisture content are observed between (1.7-30%, 40-56%) for medical and general waste respectively. While the density are (270.4 and 239), kg/m^3 for medical and general waste respectively. In addition, the number of surgical operations and the number of patients per day are shown to be most important factors affecting the generation rate of medical waste in the hospital. The treatment of medical wastes for Al-Yarmouk Hospital adopts a system of steam sterilization in a special system.

Keywords: *general waste, hospital, medical waste, shredder and Sterilization method, total waste***.**

1. Introduction

Medical waste resulting from hospital health care, diagnostics, medical laboratories, etc. is considered to be part of hazardous waste if not properly treated due to its negative effects on health workers and the community. In addition to its effect in the areas of public health [1-2].

Medical waste is defined as the waste generated within all medical and health facilities from hospitals, medical centers, clinics, health centers across the city, public and private clinics, small clinics and laboratories related to medical examinations of all types, sizes, clinics and pharmacies [3]. It Contains many pollutants coming from the practice of medical work containing the tissues, blood, bones, allowances, bottles, plastic and glass containers, blood delivery and bags. Hospitals and nursing homes generate waste containers a special and infectious substances that are disposed of either with municipal waste, or in designated for this purpose and built within the land of the hospital itself. Such procedure requires national legislation to be established. Each hospital incinerator waste classified according to the degree of its contamination [4].

The World Health Organization has shown that 80% of total waste is due to health care and is disposed to the public waste, the remaining 20% is hazardous or radioactive waste [4- 5- 6- Sheikh, 2006),]. WHO classifies hospital waste into: Household wastes. The waste of hospitalization and treatment, which is of two types: Unusual used equipment such as (Replaceable dressings), and sharp used equipment such as (glass). Surgery waste that includes two types as well: Surgery residues such as (truncated organs) and Postoperative residues such as (plastic bags for biological liquids). Automatic screening and screening equipment (film boxes and some materials used in detection laboratories, imaging materials Radiographic film). Recovered, residual or obsolete medicines, recovered, obsolete or residual solutions. Medical waste may become an important cause of illness or death if not properly managed.

The most important risk of infectious medical waste is the transmission of many diseases, such as viral hepatitis (B) or (C), as well as HIV, through wounds caused by human blood-contaminated needles, containing such viruses. There are also many chemical medical residues and treatments that are considered hazardous waste, some of which may be poisonous, flammable, harmful, or otherwise hazardous [7]. The waste consists of two main types: general waste, including food waste, meals residues for sick patients, papers, medical examination forms, medicine and cartons filled with medicines and medical supplies. This type accounts for between 75% and 90% of the total solid waste generated. Of the various varieties as listed in the introduction, These wastes account for between 15% and 25% of the total solid waste and represent the dangerous part of it, because of its ability to spread pollution and disease if it is abused, it needs a special method to manage and treated, [3- 6- 8].

Many of researchers deal with solid waste and their rates of generated in hospitals. [9] shown that a solid waste yield was 5.4 kg/bed.day average, and 19.5%, the total waste, it was a mixture of contaminated waste and sharp machines through study in one of the Lebanon hospital. [10] studied the solid waste in Benghazi hospitals in Libya and found that the rate of waste generation was 2.08 kg/bed.day and 28.5% infectious. [11] found the generation rates of solid waste for Al- Basrah Hospitals was between (1.85-3.53 kg\bed.day), the rate of medical waste was 18% of the total waste, while the general waste was 78%, and the pathologic waste was 4%. [12] found through study the solid waste management in Al-Kut hospital, that generation rate ranged between (212 -1102) kg/bed.day, in addition the moisture content and density were (19.0 % - 197 kg/ m^3) respectively for medical waste and (41%-255 kg/ m^3) respectively for general waste.

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The best solution to the solid waste problem that generated from hospitals, through adapting different steps in management to work before addressing the treatment, begins with the precise sorting of medical waste on the public and reducing the generating sites. Others shown that it is necessary to develop a program to prevent the use of hazardous materials by establishing rules for responsible financing for the purchase of less hazardous materials to use more than once [13]. In addition, this system should be given great attention by officials through the provision of material support in order to provide necessary requirements, also required raising the awareness of specialized staff of collecting. Transporting waste and ensuring protection from the risk of pollution and disease by wearing gloves and masks and, training courses should be conducted about How to collect and transport waste [13].

For the treatment of medical solid waste, in most countries of the world and particularly in Iraq was used incinerators. There are two types of incinerators Controlled Air Incinerator and Muliti stage combustion. At the first stage the solid waste is burned in burner at temperatures up to 900 °C, when the volatile materials are burned in the second stage, and the gases emitted at temperatures up to 1200 °C with smallest pollution, but this method is polluted to the environment, especially in the absence of a good operation method and continuous maintenance. They are uneconomical because of the high cost of construction and the cost of continuous maintenance [14- 15]. In order to utilize the waste as a source of energy via burning, so the recommend to collect waste from a many hospitals in one central incinerator, which also provides economic, costs [16 – 17]. Many of development countries use alternative solution as treatment for the hospitals solid waste as dry and wet thermal sterilization methods, chemical sterilization, reduction of plastic production and replacement by glass [18]

The aim of this study is to provide a clear picture about the reality of solid waste management at Yarmouk Hospital, its classification, identification of its sources of production, and the proposal of an environmentally safe management system to deal with the medical waste.

2. Fieldwork

The fieldwork have two sides: A- description the management and treatment of solid waste in AL- Yarmouk Teaching Hospital, the second side: B- studying the characteristics of solid waste.

2.1. Description the Management and Treatment of Solid Waste in AL- Yarmouk Teaching Hospital

AL- Yarmouk Teaching Hospital selected in Baghdad Al-Karkh / Yarmouk District to evaluate the state of solid waste management. This hospital characterize by the presence of a large number of medical departments in various specialties and their relatively large clinical capacities compared to other hospitals. For appropriate solutions, clinical capacity was determined in this hospital as shown in Table (1).

Table .1: clinical capacities of Yarmouk Teaching Hospital

Hospital sections	Clinical capacities
Synthetic College	٣٦
Cardiac resuscitation	٢٤
Psychiatry	١٨
Transient and communicable diseases	٢٢
Joints and medical qualification	١
Leather	١
Urinary Surgery	٣٨
Surgery fractures	٥٦
General Surgery	٦٦
Chest surgery	١٢
Transient and communicable diseases	٣٦
Oral and Maxillofacial Surgery	٤
Eye surgery	١٨
Burn surgery	١٢
Ear, Nose and Throat	١٩
Women and Generation	٩١
Preterm and neonatal	٢٠
Intensive care	١٢
Total number of family	٩٩٢

To evaluation the administrative structure of the hospital waste management system and the method used in the collection, transport, storage and treatment of solid waste, the steps below were be Followed:

2.1.1. The Administrative Structure of Al- Yarmouk Hospital Solid Waste Management System.

The solid waste management of Al- Yarmouk Hospital is the responsibility of the Public Health Department of the Ministry of Health in cooperation with the Municipality of Baghdad. The Department of Public Health is responsible for providing services to the hospital and includes cleaning, collecting and transporting waste, cooking, catering for sick patients, cleaning supplies, bags and special containers for waste collection. Also responsible to provide integrated solid waste treatment plant, and training the staff to maintain it. A special engineering department (maintenance department) should be provided which is responsible for maintaining the electrical and medical equipment.

2.1.2. The Solid Waste in Hospitals is collected in containers with different shapes and measurements, blue color in general. The bags used for medical waste are yellow and the black bags are for general waste. Figure 1 shows the use of colors in the collection of medical and general waste at Yarmouk Hospital. The hospital's cleaning workers wear a uniform for cleaning workers, wearing Gloves and masks to collect waste from operating rooms, patient rooms, kitchens and other sources.



Fig. 1: medical and general waste collection in Yarmouk hospital.

2.1.3. Storage of Waste

Waste generated from the hospital's sections is treated on a daily basis. All waste is transported daily to the treatment plant, which is operated 24 hours a day to prevent its accumulation inside the hospital. The Waste from the treatment plant is treated as a public waste and it is the responsibility of the Municipality of Baghdad, and shown in Figure (2).



Fig.2: shows the blue container after sterilization processing waste collection in preparation for combined with General waste

2.1.4. Solid Waste Treatment at Al-Yarmouk Hospital

Unlike all the hospitals in Baghdad, which contain Incarnation for treatment the medical waste, Al-Yarmouk Hospital has a special medical waste treatment plant (Shredding and sterilization). It has

cooperation with the Italian company (Schroeder) for building and maintaining the plant. This plant consists of four parts.

a. Conveyor belt: Medical waste is collected on a 24-hour basis from all parts of the hospital by special bags to place these bags on the belt conveyor for the purpose of transport for the Shredding and sterilization as treatment. This is illustrated in Figure (3)



Fig. 3: medical waste conveyor belt yellow pillowcases

b .Shredding: When the waste bags arrive in the orange containers containing the yellow as shown in figure (4). The waste bags transported through the conveyor belt, the waste cut into very small pieces through the cutter to increase the surface area to reach all parts during sterilization.



Fig. 4: containers used for transporting medical waste sterilizer

c. Sterilization: in this process. The waste sterilized by water vapor at a temperature of 134 °C, for 10 minutes, to ensure sterilization completely. In a vapor temperature no organism can live, this method is free of any emissions harmful to the environment as in incinerators, Figure (5) shows the sterilization device used to sterilize the medical waste at Al-Yarmouk Hospital.



Fig. 5: user sterilizer to sterilize medical waste at Yarmouk hospital.

d. Transport of generated waste: After the sterilization process, the waste transported to special containers for the treatment plant and transported as general waste. It is the responsibility of the Municipality of Baghdad. Figure (6) shows the container used to transport the waste after sterilization.



Fig. 6: the container used to transport the waste after sterilization.

2.1.5. Studying the Characteristics of Solid Waste and identifying the most prominent characteristics of these wastes in terms of the rate of their generation, their basic components (physical composition) and their moisture content, that details show in result and discussion.

3. Result and Discussion

3.1. Rate of Waste Generation

The results of the solid waste generation rate analyzed best on the medical and general generation rate. The rate of solid waste generation in the hospital measured by the method during distribution plastic bags, each bag is labeled as a section containing its accumulated waste for 24 hours, weighed the contain of each bags and weighed by a balance. Daily, samples were taken from each department of hospital during 15/9/2017 to 31/12/2017. Obstetrics and Gynecology at Al- Yarmouk Hospital is considered one of the most specialized and productive medical specialties for medical solid waste, especially if we know that the placenta weight resulting from the birth of only one person is not less than 1 kg, in addition other accessories of waste.

The rate of solid waste generation varies from one sector to another according to several factors, such as its clinical capacity, the number of patients in the hospital and the number of operations per day. In addition, the surgical department is one of the solid waste producing departments in large quantities compared to other countries. The country is in a state of instability and insecurity, making it on going to receive victims of this situation, thereby increasing waste production. It was noted that more than 50% of the medical waste of the hospital is generated in the rooms of patients who are lying and delivery halls and operations, while in most hospitals occupy the highest proportion of the production of public waste. The rest of the departments enjoy the rate of waste production on a daily basis, according to the specialization of the department and the rate of patients. Figure (7), (8), (9), and (10) show the change in the rate of solid and medical waste production in hospital departments. Table (2) shows the rate of bed, patient, and per capita production of solid waste per day for hospital departments.

Table.2: Rate of output per bed / patient and per person of solid waste per day in each of the hospitals covered Search:

Nuclear radiation	maternity section	Section fractions	Department of Internal Medicine	sections	
٠,٥٩	٠,٦٣	٢	٠,٢٩	Kg / bed / day	solid waste
٥,٢	١٤	٤,٩	٠,٧	Kg / patient / day	
٠,٢٩	٠,٢٩	٠,٤٣	٠,١٣٩	Kg / person / day *	

The average per capita production of solid waste in the hospital is equal to the total amount of solid waste per day (number of patients per day) + the number of staff working in the department.

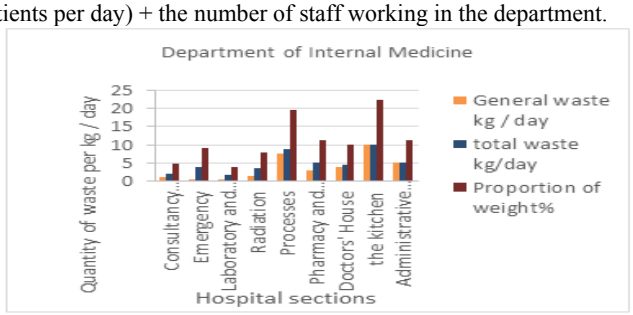


Fig. 7: The amount of public and medical waste in the Department of medicine

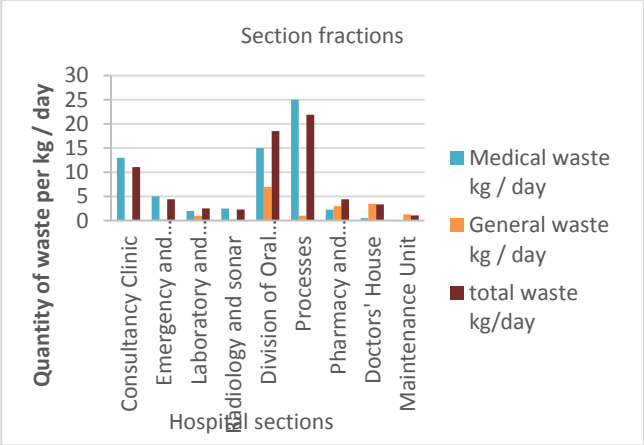


Fig. 8: The amount of public and medical waste in the fractions.

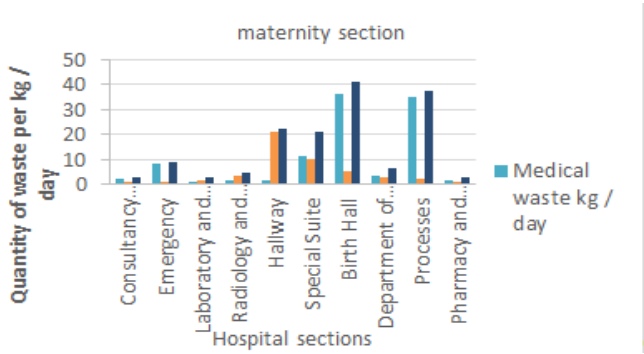


Fig. 9: The amount of public and medical waste in obstetrics.

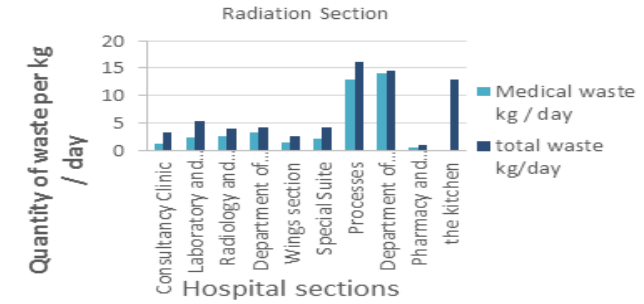


Fig.10: The amount of public and medical waste in the radiation Department.

The rate of solid waste generation varies from one department to another depending on several factors including:

1. Competence of the Department.
2. Clinical capacity.
3. The number of patients who are in hospital and the number of operations if found in one day.
4. Number of staff working there.

To illustrate this, the overall solid waste generation rate is affected by all of the above factors, while the rate of medical waste generation is affected by the first three factors, as the number of hospital staff is not at all medical waste, making it ineffective.

3.2. Classification of Solid Waste

For giving a clear picture of the nature and quality of solid waste of the hospital departments, the physical structure of the components and their characteristics have been studied. The classification of the solid waste components of the hospitals at each visit was done at a rate of THREE times for each department during the previous inspection months. Due to the small quantity of waste generated in each of these sections, each component was sorted for 24 hours by hand and categorized According to the basic components to the following:

1 - Plastic: bags, syringes, tubes, paws, bottles and others.

2 - Glass: includes empty medicine bottles and containers of expired medicines or chemicals and glass tools and contaminated with the blood of the patient body or waste.

3 - Textile materials: include waste cotton, gauze, ligaments (Bandj) and contaminated sheets and others.

4. Minerals: Needles, bottles and metal cans filled with drugs or chemicals, staples, staples, scalpels, metal surgery yarns, and so on.

5 - Organic substances: include all parts of the human body, which cut or amputated during surgery and include the outcomes of the birth process.

6- Paper and cardboard: All paper waste includes medical examination forms, treatment papers, boxes of chemicals, medical equipment and all papers used in the management of hospital affairs.

7 - Residues of food: include the remnants of meals provided to the deceased patients and the remnants of food produced during the process of cooking food in the kitchen.

Each of these components was weighed by a spiral spring balance and then was obtained a percentage of the weight of those components from the total weight of waste in each hospital. Table (3) shows the average daily weight of each of the basic solid waste components in each section throughout the study period.

Figure (11-12-13-14) shows the percentages of the weight of each waste component for each section of the hospital

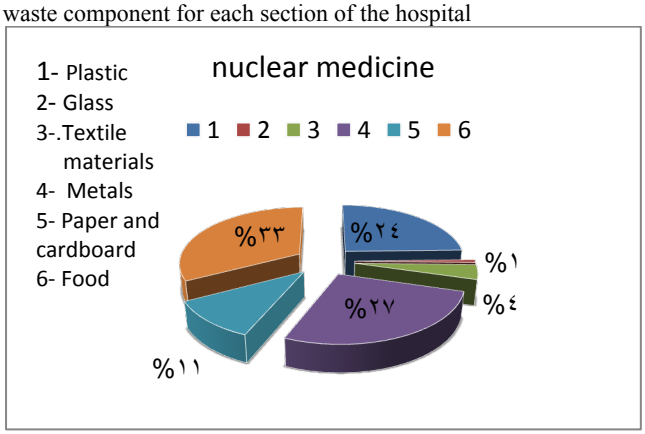


Fig. 11: The percentage of the weight of each of the components of waste.

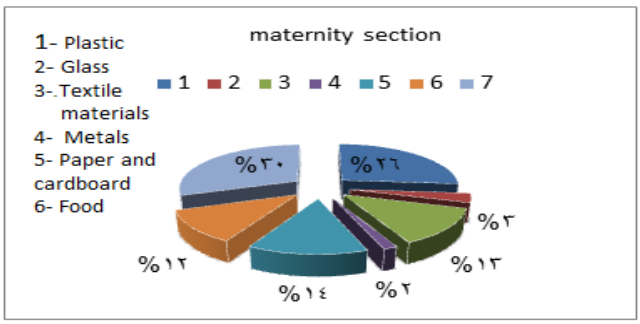


Fig. 12: percentage of the weight of each of the components of waste.

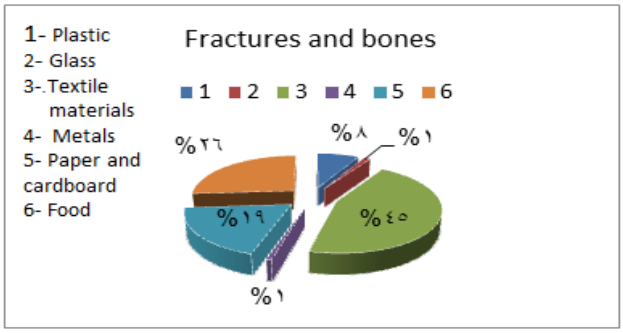


Fig. 13: The percentage of the weight of each of the components of the waste

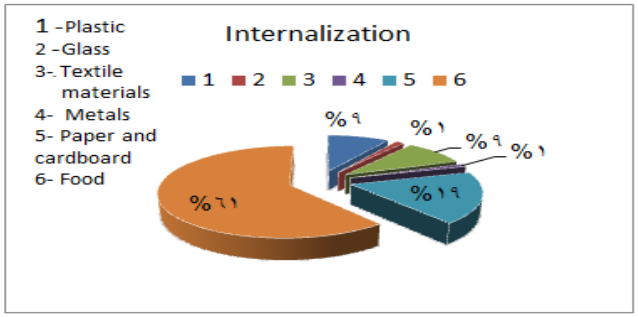


Fig. 14: Percentage of the weight of each of the components of waste.

3.3. Physical characteristics of solid waste: In general, the different methods need to treat each types of waste in hospital general and medical. The general waste must be isolated from the medical. Therefore, the physical and chemical properties of each of these two types tested separately. Moisture content is a rate of the water weight within the waste sample, to the total weight of the sample, as the type of specialization of the department has a significant impact on the quality and nature of its solid waste. therefore, were will be a significant impact on moisture content so that the moisture contains variety comes from department relative to different Function of them. Moisture content can be calculated according to the following law:

Table 3: Average daily weight for each of the components of solid waste in our sections.

Hospital sections	Plastic kg/day	Glass kg/day	The fabric kg/day	Metal kg/day	Organic kg/day	Paper + carton kg/day	food waste kg/day
nuclear medicine	١١	١,٥	١	١,٣		١,٧	٢٩
Birth	١٣,٥	١١	٢٦	٥	٥٠	٧	١١٥
Fractures and bones	٤	٣،٢٥	٥٥,٥	١,٥		٦	٤٥
Internal	١,٤٥	٢	١,٥	٠,٦		١,٧	٣٣,٢٥
Total	٢٩,٩٥	١٧,٧٥	٨٤	٨,٤	٥٠	١٦,٤	٢٢٢,٢٥

$$\text{Moisture contain \% (MC)} = \frac{wet\ weight - dry\ weight}{wet\ weight} * 100 \qquad (1)$$

From the results, noted that the residues of food have the highest moisture content for containing a high proportion of water, moisture content in all departments' ranges (35 - 56). Figure (15) shows the relationship between moisture content of hospital departments

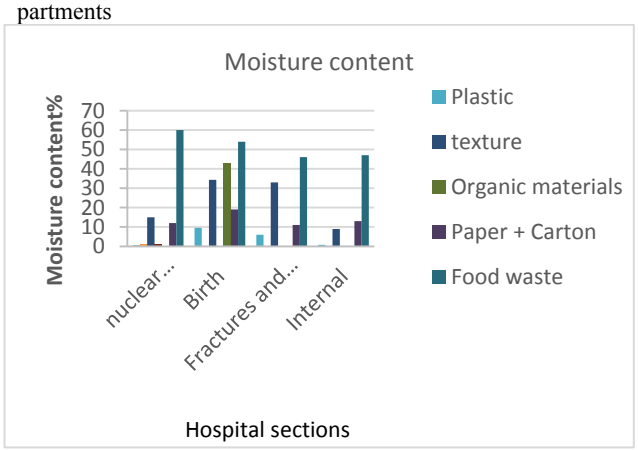


Fig. 15: Moisture rate of solid waste components of sections as a percentage of weight

It is possible to obtain the moisture content of the medical waste and the moisture content of the general waste for each section as shown in Figure (16), assuming that the medical waste includes plastic, glass, textile, metals and organic materials such as Paper and cardboard.

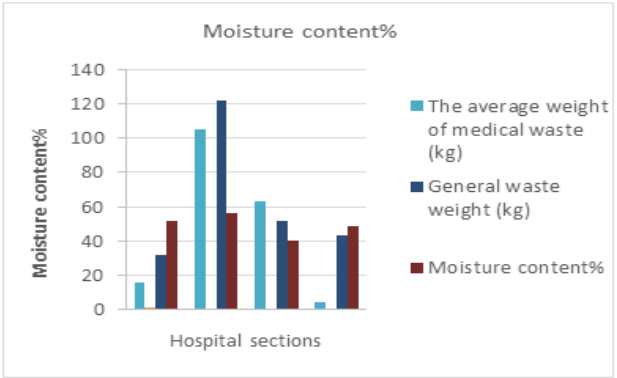


Fig. 16: Moisture content of medical waste and moisture contents of general waste for each section

The value of solid waste density depends mainly on the nature of waste and proportions of its components, moisture content and their degree of compression. To obtaining the total density of solid waste in each hospital, the density of each of its basic components was calculated at the rate of one sample per month for each department. a 20-liter container was used, filled with waste components, from weight of this waste to their size the density of each was calculated as shown in Figure (17).

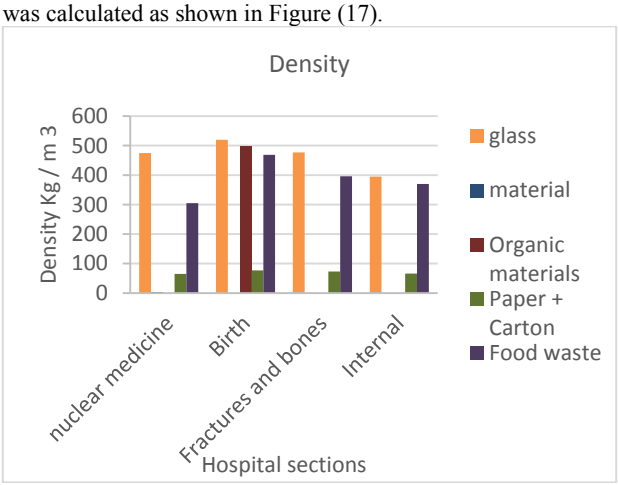


Fig. 17: Average density of each of the solid waste components of hospitals

For the purpose of obtaining a volume of waste components, the weight of each was divided into its density, and then detaining the total size of the medical waste and general waste as shown in figure (18) in addition to the density of each of them in each section as shown in Figure (19).

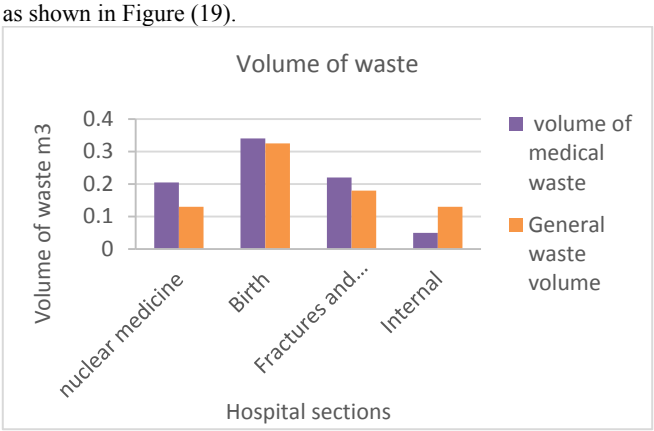


Fig. 18: The total volume of medical waste and general waste

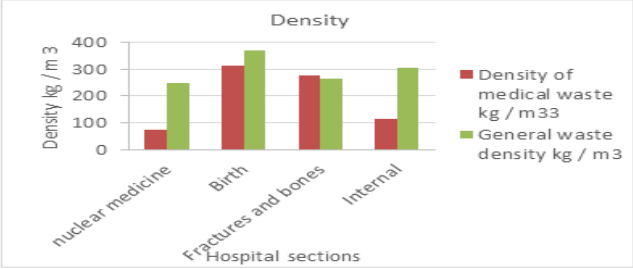


Fig. 19: The total density of medical waste and general waste

- Total medical waste weights for all sections = 220.4 kg.
- Total volume of medical solid waste for all sections = 0.815 m^3
- Total density of medical waste = 270.43 kg / m^3
- The total weight of the general solid waste for all hospitals = 224.15 kg
- Total volume of general solid waste = 0.765 m^3
- Total density of public waste = 239 kg / m^3

From the obtained results, there is a close correlation between the contents of moisture and the density of waste as the increase in moisture content is accompanied by an increase in density in addition to the results of the density is significantly affected by pressure on the waste during the process of collection and transport. Figure (20) shows the variation in total solid waste production in the surveyed sections

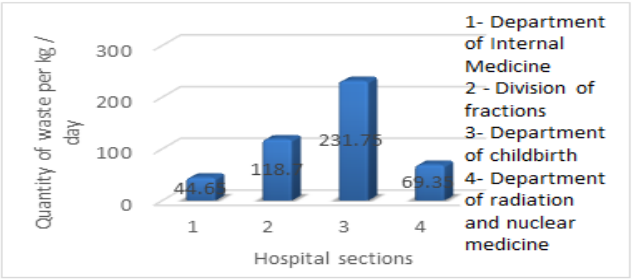


Fig. 20: The variation of the production of solid waste in the studied sections

4. Conclusions

From the fieldwork, the following could be inferred:

1 - There is some obvious negligence in the sections covered by the research, particularly the system of good management of solid waste due to the lack of health awareness among its employees.

The following are the negative and positive aspects of the study:

- Workers do not wear gloves and masks when collecting waste sometimes.
- Isolation of general waste from medical.
- Providing specialized and suitable places to store medical waste along with providing adequate quantities of waste collection bags and in specific measurements and colors.
- Preparing an integrated medical waste treatment system with integrated maintenance by the manufacturer.

2- The rate of production of each department (internal medicine, birth, bone, fractures, nuclear medicine) of total solid waste during the day was (44.65 \ 69.35 \ 118.7 \231.75 kg) respectively, while the rate of production of medical solid waste per day was (11.65 \ 65.25 \ 102.75 \ 40.65) kg, respectively.

3. The rate of solid waste generation in surgical department (birth, fractures and bones), reaches to more than 50% of the total solid waste generated during the day, while general waste accounts for between 60-90% In each department (nuclear medicine, internal medicine) by virtue of the specialization of these sections that are distinguished by the lack of production of medical waste compared to the public.

4- The rate of production per bed of solid waste per day in those sections was (0.87) kg while the rate of production of one patient during the day in those hospitals was (0.28) kg.

5. The rate of solid waste generation in surgical and operating theaters and inpatient rooms is higher than the rest of the hospital.

6 - The rate of solid waste generation depends on the specialization of the department, its clinical capacity, the number of patients in hospital, the number of operations if any during the day and the number of staff working there.

Acknowledgement

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