

## Assessment of medical solid waste generation rates for teaching hospitals in Baghdad city

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### Abstract

Medical solid waste occupies great importance in all the countries and communities because of the extreme seriousness on living organisms and the environment, this study focused on this type of waste through calculating average generation rate (G.R.) of medical solid waste in Baghdad, Iraq. Two teaching hospitals of different bed capacities in the capital of Iraq were investigated during four months. The collected data were analyzed by using IBM SPSS statistic 23 software, result showed the medical solid waste generation rate at Al-Kadhimiya teaching hospital (1.007 kg/patient/day, 0.436 kg/bed/day) was higher than Al-Yarmouk teaching hospital (0.916 kg/patient/day, 0.682 kg/bed/day). In Al-Kadhimiya teaching hospital, the generation rate of medical solid waste based on the number of beds is small due to the fact that the emergency with a large bed capacity of 100 beds compared to 32 beds at Al- Yarmouk teaching hospital. The generation rate of medical solid waste based on the number of patients in Al- Kadhimiya teaching hospital is high because that the number of patients coming to Al- Kadhimiya teaching hospital is less than that of Al-Yarmouk teaching hospital.

**Key word:** Medical solid waste, Baghdad's hospitals, Generation rate, Assessment

### 1. Introduction

Medical solid waste causes a serious problem for the public health and environment. This type of waste must have a good management program to dealing with it from its generation to ultimate disposal to prevent any harm on human beings and environment. The World Health Organization defined all the types of waste resulted from healthcare

institutions, laboratories and researches as medical waste. Healthcare waste consist of general waste and hazardous waste where they may contain toxic chemicals, genotoxic waste, heavy metals and radioactive waste in addition to infectious waste and other components of medical waste [2]. The potential problems resulting from medical solid waste was

highlighted during a survey on 22 of the developing countries in 2002, their results were between 18% to 64% of healthcare facilities using inadequate waste disposal methods [18]. Medical solid waste was grouped into two main portions, hazardous solid waste, and nonhazardous. The hazardous medical solid waste divided into three categories which are infectious solid waste which consists of body tissues, needles, blood, etc., infectious and toxic wastes consist of chemical waste, wastes from laboratories, etc., and wastes of toxic nature only that consist of expired drugs, dangerous organic wastes, mercury wastes etc.

The nonhazardous solid waste has the same properties of municipal solid wastes, so they dispose of with municipal solid wastes [3]. Average generation rates of waste are calculating in kg/day or kg/year, when comparing different medical facilities with various levels of actions usually using kg/bed/day and kg/patient/day [20]. The amount of wastes generation rate is varied according to several factors such as economic and social conditions of the patients, type of healthcare institution, hospital specialization, available segregation of waste, the bed capacity of hospital, number of patients treated daily and seasonal variation [13]. A study of four hospitals in Turkey by Altin et al., 2002 resulted in 985 kg/day as a daily generation rate. Gayathri and Kamala, 2004 have found the

average generation rate of non-infectious waste was 250 kg/day and average generation rate of infectious waste was 101 kg/day when they studied a hospital and medical research center in Belgaum, India. Longe and Williams, 2005 investigated four hospitals in Lagos metropolis, Nigeria and they found that average generation rate in these hospitals was range from (0.562 kg/bed/day to 0.670 kg/bed/day), and 4.42 kg/bed/day in teaching hospitals of Tehran University by Dehghani et al., 2007. In addition, Felicia et al., 2007 found generation rates were 0.60 kg/patient/day in their study for two hospitals in South Africa. Sanida et al., 2008 showed that medical solid waste generation rate was ranged between 0.51 to 1.22 kg/patient/day or 0.26 to 0.89 kg/bed/day in Central Macedonia, Greece, and ranged from 2.41 to 3.26 kg/bed/day in Taiwan according to Cheng et al., study in 2008. Also, Sawalem et al., 2008 calculated medical solid waste generation rate in fourteen healthcare facilities in three cities of Libya and their result was average generation rate (Gr.) was 1.3 kg/patient/day. In 2011, Mesfin et al. were concluded that average generation rate for medical solid waste was ranged from 0.361-0.669 kg/patient/day during their study for six hospitals in Ethiopia. During their study Kei et al., 2013 found that the average generation rate was between 0.61 kg/bed/day and 1.03 kg/bed/day. In 2015 Victor et al., made a study in Liberia from

this study they investigated that the generation rate was 8-15 kg/day at the hospital and 0-7 kg/day for clinic and health center. A private hospital of 225 beds has average generation rate of 1.52 kg/bed/day in Rangpur, Bangladesh [11]. Also, in Lebanon Olivia et al. 2014 found that large private hospitals above 200 beds have average generation rate of 2.45 kg/bed/day and 0.94 kg/bed/day for hospitals less than 200 beds. The research aim's to comparing the daily medical solid waste weights between two teaching hospitals have almost the same characteristics in terms of functionality and bed capacity in Baghdad city using IBM SPSS statistic 23 software in order to explain which hospital has more credibility in their data, and finding the average daily medical solid waste generation rate in both hospitals.

## 2. Material and Methods

### 2.1 Case study description

Baghdad is the capital of Iraq; Tigris river divided it into two parts which are al- Karkh and the Rusafa, in the study, two hospitals were chosen at al- Karkh. these hospitals are Yarmouk hospital, a teaching hospital affiliated with the faculty of medicine / University of Mustansiriya and the hospital located in the Yarmouk region in Karkh district of Baghdad and its coordinates are ( $33^{\circ} 17' 39.5''$  N,  $44^{\circ} 21' 9''$  E). The bed capacity in al-Yarmouk teaching hospital is 647 where 32 beds are for emergency

services. It is a general hospital containing all disciplines. Al-Kadhimiya hospital, as a teaching hospital affiliated with the faculty of medicine / Al- Nahrain University and the hospital located in the new Al-Hebnaa area where overlooking the street 60 in Karkh district of Baghdad and its coordinates are ( $33^{\circ} 22' 33.9''$  N,  $44^{\circ} 19' 35.7''$  E). The bed capacity in Al- Kadhimiya teaching hospital is 659 and 100 beds are for emergency services. A general hospital containing all disciplines, which are internal Medicine section, surgery department, psychiatric, neurological diseases, blood diseases, oncology treatment, women's section, children's section, laboratories, as well as emergency and the private section.

### 2.2 Data collection and analysis

We have numerous visits over four months (September, October, November and December 2016) during this period, data were obtained from each hospital was a monthly medical solid waste weights for three years (2014-2015-2016) in addition to the preparation of the patients are asleep, and the number of beds available for the same period. The information from the department of statistics collected and has scheduled by excel program and transferred this data to IBM SPSS statistic 23 software for the purpose of analysis as well as from the division of public health has been collecting data sheets containing the

weights of medical solid waste which also arranged in a tables and use IBM SPSS statistic 23 software for the analysis. These data were analyzing to found the average amount of generation rate for medical solid waste at each hospital and also some descriptive analysis.

### 3. Medical solid waste concept

Medical solid waste can be categorized to sharps, infectious waste, pharmaceutical waste, chemical waste, genotoxic waste, pressurized containers, radioactive waste, and waste with heavy metal content [15]. If infectious waste was not treated in a manner that kills all pathogenic bacteria, organisms, viruses and etc. It will pose a serious threat through the transfer of diseases to living organisms because of the existing microorganisms in large quantities [1]. Exposure to medical solid waste cause dangerous health impacts such as mutagenic and carcinogenic effects and cause damage for reproductive system, central nervous system, etc. in addition to bad impact on environment like foul odor, rodents, flies, vermin [5]. Medical solid waste generation rate related to type and size of medical establishment, but it changes from country to country according to growth of economic where the developed countries produce higher quantities of medical waste [12]. One of the most important elements that reflect the waste management system is generation rate [16]. In this study,

the monthly weight was converted to equal weight generation load. generation rates (kg/bed/day, kg/pat./day) were found by using the following equations:

$$GR. \left( \frac{\text{kg}}{\text{bed}} \right) = \frac{\text{weight of medical solid waste } \left( \frac{\text{kg}}{\text{day}} \right)}{\text{number of hospital's bed}}$$

.. eq. (1)

$$GR. \left( \frac{\text{kg}}{\text{pat.}} \right) = \frac{\text{weight of medical solid waste } \left( \frac{\text{kg}}{\text{day}} \right)}{\text{number of patients}} \quad ..$$

eq. (2)

#### 3.1 Medical solid waste treatment

Some of methods used for medical solid waste treatment are chemical disinfection, microwave disinfection systems, incineration, autoclaves and retorts. Medical solid waste disposal methods include: open dump, pits, controlled landfill and sanitary landfill [9]. In Iraq, specifically in AL- Kadhimiya and Al- Yarmouk teaching hospitals the method of treatment use is advance autoclave (a pre-shredding autoclave) this device use steam of temperature about 134<sup>0</sup>C for the purpose of disinfection to kill any microorganisms that may found in the medical solid waste see plate (1).



**Plate 1. Medical solid waste treatment-autoclave uses AL- Kadhimiya and Al-Yarmouk teaching hospitals**

#### 4. Results and discussion

Descriptive Statistics for medical solid waste weights for al-Yarmouk teaching hospital and Al – Kadhimiya teaching hospital are shown in Table (1). As shown in Table (1) the daily weights mean value (446.747) kg/day in al-Yarmouk teaching hospital is higher than Al – Kadhimiya teaching hospital (279.618) kg/day although the number of beds in both hospitals approximately the same, this difference is reflected on the same level on the standard error of the mean where we note that the standard error is more accurate,

suggesting the presence of dispersion in mean value. Also, the standard deviation of al-Yarmouk teaching hospital (146.869) kg/day is much higher than the standard deviation of Al – Kadhimiya teaching hospital (65.486) kg/day and this refers to that the data of Al-Kadhimiya teaching hospital is more accurate than al-Yarmouk teaching hospital, in other words the dispersion in data of al-Yarmouk teaching hospital is higher. From eq. (1) and eq. (2) the average generation rates in (kg/bed/day, kg/pat./day) were computed for each one of the two hospitals see Table (2). According to Table (2) Al-Kadhimiya teaching hospital showed (1.007 kg/patient/ day) as highest value in generation rate that depends on patient's numbers this indicates that the number of patients in this hospital less than the number of patients in al-Yarmouk teaching hospital. In Iraq, many factors can affect the ratio of medical solid waste generation due to the current situation of the country such as an explosion, the economic situation and provide all medical care in the hospital accessories addition to the factors mentioned in the previous paragraphs. Annual average generation rate for medical solid waste was also calculated for each hospital and clarified in figures (1) and (2). Covariance between the two hospitals in average generation rates clearly shows in these figures. The result of average generation rate that we found ranged between (0.436 –

0.682) kg/bed/day and (0.916 – 1.007) kg/ patient/day, a comparison with some previous study show that our results agree with Sanida et al., 2008 and Felicia et al., 2007 in the

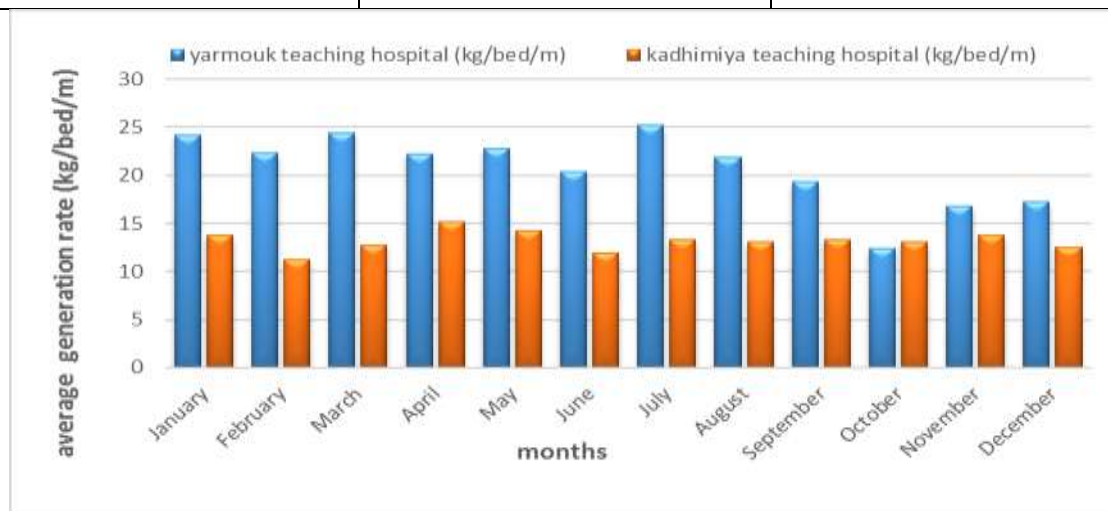
case of kg/patient/day. while in case of kg/bed/ day, they are agreeing with Kei et al., 2013 and disagree with Cheng et al. study in 2008.

**Table 1. Descriptive Statistics for medical solid waste weights in each hospital**

Hospital	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic (kg/day)	Statistic (kg/day)	Statistic (kg/day)	Std. Error	Statistic (kg/day)
Al-Kadhimiya hospital	32	83.483	402.267	279.618	11.576	65.486
Al-Yarmouk hospital	34	35.774	632.258	446.747	25.188	146.869

**Table 2. Average medical solid waste generation rates**

Hospital	(kg/bed/day)	(kg/pat./day)
Al-Kadhimiya teaching hospital	0.436	1.007
Al-Yarmouk teaching hospital	0.682	0.916



**Fig 1. Medical solid waste annual average generation rate (kg /bed/ month)**

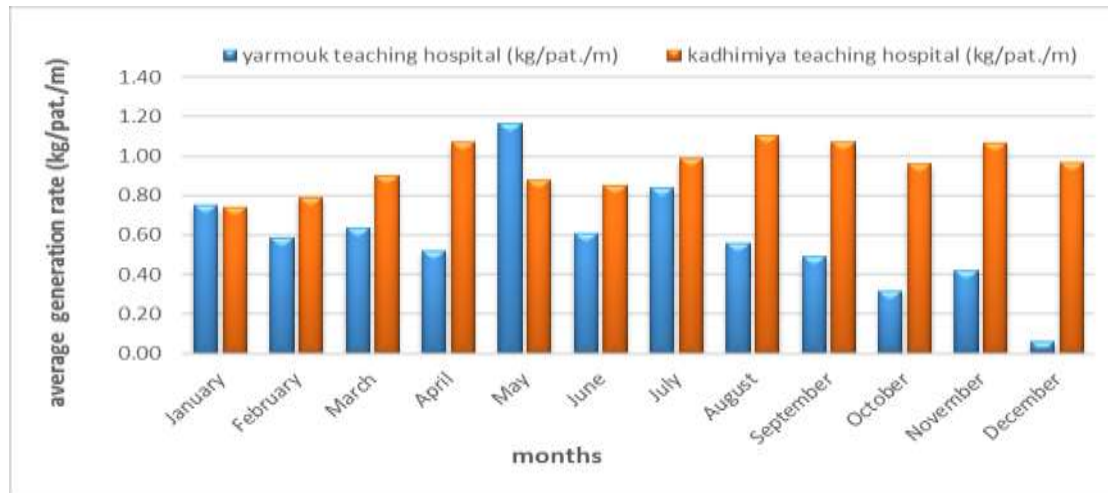


Fig 2. Medical solid waste annual average generation rate (kg /patient/ month)

## 5. Conclusion:-

The hospitals concerned to study providing services for people from all places not only from Baghdad city but, also from other Iraq's provinces and therefore, the proportion of medical solid waste generated within the hospital suffering variation in their quantity. The weights of medical solid waste analyzed statistically using IBM SPSS statistics 23 software, as we showed Al-Kadhimiya teaching

hospital has highest generation rate in the case of kg per patient per day this may due to the number of patients who come to the hospital is less compared with Al-Yarmouk teaching hospital. As appeared Al-Yarmouk teaching hospital was the highest in the case of kg/bed/day meaning that the presence of the patient in bed be for a short period and the emergency services may receive a large number of patients.

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### تقييم معدل توليد النفايات الصلبة الطبية لمستشفيات التعليمية في مدينة بغداد

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الخلاصة :-

تحتل النفايات الطبية الصلبة أهمية كبيرة في جميع البلدان والمجتمعات بسبب خطورتها البالغة على الكائنات الحية والبيئة. ركزت هذه الدراسة على هذا النوع من النفايات وذلك بحساب معدل تولد (GR.) النفايات الطبية الصلبة في العاصمة العراقية بغداد. وقد تم التحقق من اثنين من المستشفيات التعليمية ذات السعات السريرية المختلفة في العاصمة العراقية خلال أربعة أشهر. تم تحليل

البيانات التي تم جمعها باستخدام IBM SPSS statistic 23 software , و أظهرت النتائج ان معدل تولد النفايات الطبية الصلبة في مستشفى الكاظمية التعليمي (1.007كغم/مريض/يوم 0.436 , كغم/سرير/يوم) كانت اعلى من مستشفى اليرموك التعليمي (0.916 كغم/مريض/يوم, 0.682 كغم/سرير/يوم). في مستشفى الكاظمية التعليمي, معدل تولد النفايات الطبية الصلبة بلاعتماد على عدد الاسرة قليل وذلك يعود الى ان الطوارئ ذات سعة سريرية كبيره وهي 100 سرير مقارنة مع 32 سرير في مستشفى اليرموك التعليمي. ايضاً سبب كون معدل تولد النفايات الطبية الصلبة بلاعتماد على عدد المرضى في مستشفى الكاظمية التعليمي عالي هو ان اعداد المرضى الوافدين على مستشفى الكاظمية اقل مقارنة مع مستشفى اليرموك التعليمي.

**الكلمات الرئيسية: النفايات الطبية الصلبة, مستشفيات بغداد, معدل التولد, تقييم**