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Letter to Editor

Determination of Hospital Waste Composition and Disposal Methods: a Case Study

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Abstract

The fundamental information for selecting and designing the most efficient treatment method of hospital waste is obtained by means of waste composition analysis. Therefore, the aim of this study was to evaluate the physical and elemental composition of waste in four hospitals in Sivas, Turkey. The results should help us select and design proper waste disposal. During the study period it was estimated that the daily waste generation rate of four hospitals was 985 kg/day, projected to be 1267 kg/day in 2015. Furthermore, analysis indicated that the moisture content of wastes was 14,2 % . The four hospital wastes consist of 92% combustible wastes and 8% noncombustible wastes by mass. The combustible wastes constitute paper (16%), textiles (10,2%), cardboard (4%), plastics (41,2%) and food waste (17%). Since the ratio of combustible waste is high, the incineration method has been suggested as a proper disposal method.

Keywords: hospital wastes, composition of hospital waste, disposal of hospital waste

Introduction

Hospitals are a place where patients' problems are diagnosed, analyzed and treated. During these activities generation of solid waste is unavoidable. This solid waste described with the term "hospital waste", refers to all waste, biological or non-biological that is discarded and will never be used again [1,2]. Hospital waste consists of mainly three group wastes: medical waste, infectious waste and domestic waste. "Medical waste" refers to materials accumulated as a result of patient diagnosis, treatment or immunization of human beings. "Infectious waste" refers to the portion of medical waste that is in contact with a patient who has infectious disease and it is capable of producing an infectious disease. Most of the time, medical waste is considered to be infectious waste, if medical waste and other waste is not collected separately. If all waste is mixed then the hospital waste is presumed to be infectious waste.

Traditionally, hospital wastes have been disposed of with the municipal wastes in landfills. However, since the late 1980's, the spreading trend of immunodeficiency virus (HIV), hepatitis B virus (HBV) and other agents associated with blood bone diseases has raised public awareness and concerns of the disposition of medical waste. As a result, medical waste is required to be treated in a special way and not to be mixed with municipal waste.

Proper medical waste management requires special treatment of medical waste such as incineration or hazardous waste landfill facilities. Former studies have shown that the best available technology for disposing of medical waste is incineration [3,4,5]. The proper collection of hospital waste will reduce the volume of infectious wastes and consequently the cost of treatment.

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As a general rule, hospital management should coordinate the collection of infectious and other wastes separately, and the local authorizes should be responsible for the treatment of infectious waste [6,7]. However, all the wastes of hospitals in question have been collected together, transported to general disposal land and mixed with municipal wastes in the city of Sivas, Turkey. Therefore, the purpose of this study was to suggest an improved system to collection, handling and disposal to meet the present and future needs of the hospitals in Sivas.

Material and Methods

Characteristics of Hospitals

Sivas is a developing city with a population of 300, 000. The number of major hospitals is four and wastes generated in these hospitals have been investigated during this study. The characteristics of these hospitals are as follows [8]:

a) Sosyal Sigortalar Kurumu Hospital (SSKH): This is the biggest hospital in terms of bed capacity (362 beds) and the number of staff (247 person). The hospital consists of 15 different diagnosis and treatment units, one operating room and surgical intensive care unit, three laboratories and other general units (kitchen, laundry, coffee shop, etc.). This hospital serves mainly employees of the private sector and their families.
b) Sivas Numune Hospital (SNH): The bed capacity of this hospital is 319 and the number of staff is 123. In addition to diagnosis and treatment units, there are 13-dialyzers to serve the patients who have kidney problems. The number of operating room and surgical intensive care units is one. There are also four laboratories in the SNH. This hospital serves mainly the employee and personnel of the state sector and their families.
c) Sivas Doğumevi Hospital (SDH): This is a maternity hospital. The number of beds is 150, and the number of staff is 108. There is one operating room, one surgical intensive care unit and one laboratory. In this hospital, only newborn babies and female patients are served.
d) Devlet Demir Yolları Hospital (DDYH): This is a small hospital with seven diagnosis and treatment units. The number of the beds is 100 and there are only 76 staff. There is one operating room and one laboratory.

As it can be seen, the four hospitals have different characteristics in terms of their size and the type of patients. It is possible that their waste composition differs. However, all wastes of these hospitals are currently collected together and transported to the general landfill area.

Sampling and Analysis

In order to determine the total daily rate and characteristics of wastes from four hospitals, each unit of hospitals has been visited every month for a period of six months. During these visits, the total medical waste of each unit was weighed. Then, the waste was separated into groups according to type of waste such as paper, textiles, plastic, glass, etc. and waste groups were weighed again. Samples were taken from each group and transported to the university laboratory in order to determine moisture content. In order to determine moisture content of waste the samples first were weighed, then dried at 105^{o}C for 24-hours and weighed again. The ratio of dried weight to weight before drying gives the moisture content as a percentage (%).

In order to estimate the hospital waste generation rate as kg/bed/day, kitchen waste of each unit was also added to each unit waste. The number of overnight patients has also been recorded. Then, the waste generation rate is calculated by the following equation:

$$W_{day} = (W_{med} + W_{kit}) / N_p$$

where;

W_{day} - waste rate (kg /bed/day-unit)
W_{med} - total medical waste (kg/day-unit)
W_{kit} - total kitchen waste (kg/day-unit)
N_p - the number of overnight patients

Results

The generation rate of hospital waste is the fundamental information for evaluating and designing the disposal system of hospital waste. Therefore, the waste generation rate of each unit of hospitals has been determined and results are given in Table 1. The daily hospitals waste generation rate was found to be a maximum of 2.6 kg/bed/day.

As can be seen in Table 1, the waste generation rate of each unit and each hospital is different. The difference is because of the characteristics of each unit. Each unit requires a different type of diagnosis and treatment. Some diagnosis and treatment methods produce more waste than others. For example, the waste per patient in the orthopedic unit is much higher than in the external disease unit.

The waste generation rates of SSKN and SNH hospitals are higher than the rates of SDH and DDYH. Since both SDH and DDYH are low-capacity hospitals, their waste generation rate is lower. When the waste generation rates of these hospitals is compared with the generation rates of hospitals given in literature, the rate is found to be low. Waste generation rates of hospitals have been estimated to be between 7-10 kg/bed/day in the United States and 2.5-4 kg/bed/day in Taiwan [4,6]. These results also indicate that waste generation rates in developed countries are higher than in developing countries.

Since these hospitals are situated close to each other, it is thought that a shared disposal method would be preferable. Therefore, the physical and chemical characterization of waste, which is the most important information in selecting and designing disposal, have been determined by mixing the waste of four hospitals. The results are given in Table 2 and shown in Figure 1.

Regarding physical analysis, the results indicate that combustible waste constitute 92% of total waste. Almost

Table 1. Waste generation rate of each unit.

	Services (SSKN)	Medical Waste (kg/day)	Kitchen waste (kg/day)	Tot. Hosp. Waste (kg/day)	Number of Overnight Patients	W_{day} (kg/d.)
SSKH	**Int. Disease**	74	36	110	48	2.29
	Ear/Nose/Thr./Eye	25	13	38	11	3.45
	Gynecology	33	22	55	21	2.62
	Urology /Dermatology	29	10	39	13	3
	Ext. Disease	36	22	58	29	2
	Orthopedic	27	28	55	11	5
	Neurology	24	14	38	19	2
	Pediatric	40	22	62	23	2.7
	Total	288	167	455	175	
	Average APP	**1.65**	**0.95**			**2.6**
SNH	**Int. Disease**	76	46	155	42	2.54
	Ear/Nose/Thr./Eye	33			19	
	Neurology/Heart	49	42	119	34	2.33
	Urology /Dermatology	28			17	
	Orthopedic	33	30	121	22	2.33
	Surgical	58			30	
	Dialysis Unit	26	--	26	18	1.44
	Total	303	118	421	182	
	Average APP	**1.66**	**0.65**			**2.31**
SDH	**Septic**	14	7	21	14	1.50
	Aseptic	12	5	15	9	1.88
	New born	8	--	8	6	1.33
	Surgical	13	7	20	13	1.53
	Total	47	19	66	42	
	Average	**1.12**	**0.45**			**1.57**
DDYH	**Ext. Disease**	9		9	14	0.64
	Int. Disease	13		13	13	1
	Gynecology	6		6	6	1
	Dermatology	0.7		0.7	1	
	Total	28.7	13.9	42.6	34	
	Average	**0.84**	**0.40**			**1.25**
TOTAL WASTE		**666.7**	**317.9**	**984.6**		

half of combustible waste is plastic, which hardly dissolves in the natural environment.

Another consideration in selecting and designing a disposal system is its future capacity. It is a known fact that the waste amount will increase with the increase in the number of patients. It is assumed that the number of patients will increase about 1% per year since the average population increase rate is about 1% in Sivas. Then the following equation is used to estimate the generation rate of hospital waste for next the 15 years.

$$WA_i = N_{pi} \; x \; P \; x \; A_p \; x \; 365$$

where:

WA_i - total waste of year i

N_{pi} - total number of beds

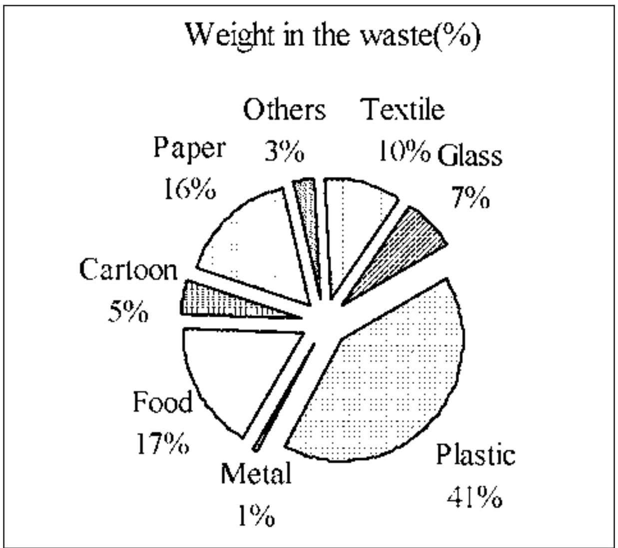
P - percentage of beds

A_p - waste per patient (kg/day)

The estimated waste generation rate of four hospitals in the year of 2015 will be about 462,455 kg.

Table 2. Physical composition of the hospital waste at SSKH, SNH, SDH and DDYH.

Kind of Waste	Weight in the Waste (%)	Average moisture content of kind of waste (%)	Moisture content in the unit waste (%)
Paper	16,1	4,5	0,72
Food	17,1	63	10,77
Textile	10,2	8,6	0,87
Cartoon	4,6	5	0,23
Plastic	41	2,8	1,15
Etc.	3	8	0,24
Combustible (%)	92		
Metal	0,8	2,25	0,02
Glass	7,2	2,05	0,15
Non-combustible (%)	8,0		
		Average	**14,15**



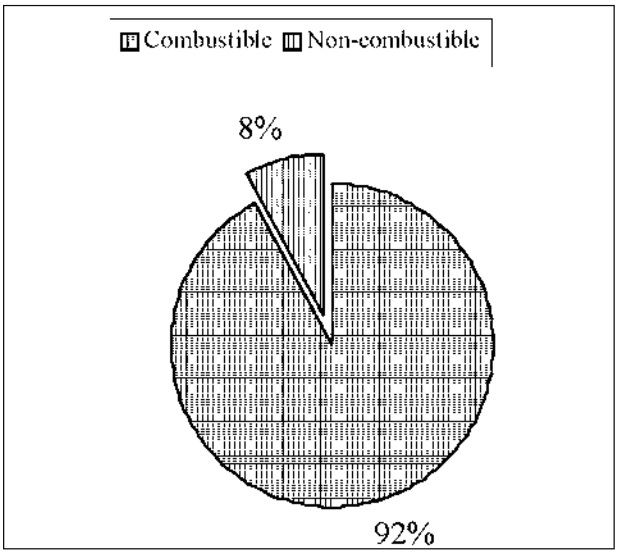


Fig.1. Physical composition of hospital waste at SSKH, SNH, SDH and DDYH.

Conclusions

A better understanding of the composition of hospital waste is fundamental in order to choose the best disposition alternative. The results of this investigation indicated that combustible waste constituted 92% of total hospital waste, while noncombustible waste only constituted 8% of total mass. The moisture content of combustible waste was only 14.2%, of which 80% was from food waste. The generation rate of hospital waste was 1.25-2.6 kg/bed/day. On the basis of these results, the following can be suggested about waste management in Sivas hospitals:

- The proper disposal method is incineration. However, individual incineration for each hospital does not seem to be economic. Therefore, one common incinerator should be designed for the hospitals in Sivas.
- The estimated generation rate of hospital waste would be 985 kg/day in 2000 and will be 1267 kg/day in 2015. Therefore, the capacity of an incineration plant should be 1300 kg/day. However, if infectious waste is collected separately, the waste generation rate will be 195 kg/day in 2015. In this case, an incineration plant with a capacity of 200 kg/day will be adequate.
- The separate collection of hospital waste (medical, kitchen, etc.) will decrease investment and operation cost of the incineration plant.

It is urgent that we select and implement a proper disposal method for the hospitals in Sivas.

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