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Sağlık Kurumlarında Atık Kovalarının Tıbbi Atık Yönetimine Göre Mikrobiyolojik Değerlendirilmesi

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ÖZ

Tıbbi atıkların yönetimi, potansiyel çevresel tehlikeleri ve toplum sağlığı dikkate alındığında büyük öneme sahiptir. Çünkü tıbbi atıkların uygun olmayan şekillerde bertaraf edilmesi insan ve toplum sağlığı açısından önemli bir tehdit oluşturabilmektedir. Bu çalışmada, sağlık kurumlarında kullanılan dezenfekte edilmiş atık kovalarının bakteriyolojik analizlerinin yapılması amaç edilmiştir. Dezenfekte edilmiş 571 tıbbi atık kovasından alınan numuneler koyun kanlı besi yeri, eozin metilen mavisi besi yeri ve krom oryantasyon ortamında üretilerek sonuçları değerlendirildi. 571 numunenin 502'inde E. faecalis, E. coli, K. pneumoniae, S. aureus, Proteus and S. Saprophyticus bakterilerinin ürediği gözlendi. Tıbbi atık kovalarından alınan numune sonuçları dikkate alındığında tıbbi atık kovalarının dezenfeksiyon işlemlerine daha fazla dikkat edilmesi ve standart enfeksiyon önleme ölçümleri yapılması gerekliliği ortaya çıkmaktadır.

Anahtar kelimeler: tıbbi atık, dezenfeksiyon, bakteri, tıbbi atık yönetimi, sağlık kurumları

Microbiological assessment of waste bins regarding medical waste management in health care institutions

ABSTRACT

The management of medical waste is of great importance due to its potential environmental hazards and public health risks because improper disposal of medical waste may pose a significant threat to human and environmental health. In this study, it was aimed to carry out bacteriologic analyses of disinfected medical waste bins used in health institutions. 571 samples taken from disinfected medical waste bins were grown in sheep blood agar, EMB agar and Chrome orientation medium and reproduction results were evaluated. Reproduction was observed in 502 samples out of 571 and the reproducing bacteria were E. faecalis, E. coli, K. pneumoniae, S. aureus, Proteus and S. Saprophyticus. Considering reproduction results of samples taken from medical waste bins, it becomes necessary to pay more attention to disinfection procedures and conform to standard infection prevention measures.

Keywords: medical waste; disinfection; bacteria; medical waste management; health institutions

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1. INTRODUCTION

As a result of overpopulation and industrialization, the increase in solid wastes and as a derivative of this, medical wastes have become a serious environmental problem. Health care waste definition and classification vary according to the national circumstances, policies and regulations. In general, waste is something, which the owner no longer needs and which is no value to him [1].

In daily life, every solid, fluid and gas material generated from production and consumption processes are called waste [2]. World Health Organization (WHO) defines the hospital waste as the total waste stream from health care establishments, research facilities, laboratories, and emergency relief donations. Table 1 shows the percentage of these waste streams from health institutions [3]. The Infectious, injurious, cytotoxic and chemical properties of medical waste make it hazardous [4]. Biomedical waste is hazardous since it has an inherent potential for dissemination of infection, both nosocomial within health care settings as well as risk of infection to persons working outside health care facilities, like waste handlers, scavenging staff and also to the general public [5]. Estimated mortality as a result of Professional exposure including infections of healthcare workers in the United States is 17–57 cases per million employees [6].

Table 1. Approximate percentage of waste type per total waste in health care institutions.

Waste Type	Percentage (%)
Non-infectious waste	80
Pathological waste and infectious waste	15
Sharps waste	1
Chemical or pharmaceutical waste	3
Pressurized cylinders, broken thermometers, etc.	<1

1.1. Health Care Wastes

Health Care Wastes include different sub groups as seen in the following [1]:

a) Infectious health care wastes, including discarded materials or equipment from the diagnosis, treatment and prevention of diseases in health care institutions.
b) Sharps, whether contaminated or not, should be considered as a subgroup of infectious health care waste.
c) Pharmaceutical health care wastes are pharmaceuticals, expired or no longer needed containers and or packaging, items contaminated by or containing pharmaceuticals.
d) Genotoxic health care wastes consist of or contain substances with genotoxic properties including cytotoxic and antineoplasmic drugs as well as genotoxic chemicals.
e) Chemical health care wastes are chemical substances including laboratory chemicals, film developer, disinfectants expired or no longer needed, solvents, cleaning agents and others.
f) Radioactive materials include unused liquids from radiotherapy or laboratory research, contaminated glassware, or packages.

1.2. Health Care Waste Management

Healthcare waste management is a process to help ensure proper hospital hygiene and safety of health care workers and communities. It includes planning and procurement, construction, staff training and behavior, proper use of tools, machines and pharmaceuticals, proper disposal methods inside and outside the hospital and evaluation.

The effective management of health care waste can be supplied by three basic processes such as minimization, segregation and proper identification of the waste. In the past, there were no incentives to separate, recycle, or reduce waste. Appropriate handling, treatment and disposal of waste by type reduce costs and do much to protect public health. Segregation at source should always be the responsibility of the waste producer. Segregation should take place as close as possible to where the waste is generated and should be maintained in storage areas and during transport.

The waste generated from the treatment of patients suffering from infectious diseases may spread infection either through direct contact or indirectly through the environment. Transmission of infectious diseases is a serious matter. Therefore, an appropriate waste management system is essential. The World Health Organization, 1983; US Environmental Protection Agency, 1986; US Environmental Protection Agency, 1991; US Centers for Disease Control and Prevention, 1978; Muhlich et al., 2003; and many other countries have already established strict guidelines for the management of infectious waste materials disposed from medical institutions [3,7,8,9,10].

Segregation is the process of separating different types of waste at the point of generation and

keeping them isolated from each other. Appropriate resource recovery and recycling technique can be applied to each separate waste stream. Moreover the amount of hazardous waste that needs to be treated will be minimized or reduced subsequently prolonging the operational life of the disposal facility and may gain benefit in terms of conservation of resources. The most appropriate way of identifying the categories of health care waste is by sorting the waste into color-coded plastic bags or containers.

Infectious waste materials disposed from hospitals and clinics are defined as industrials waste and infectious waste materials are also categorized as one type of the most important problems in medical institutions [11, 12, 14]. Table 2 shows the classification of waste generated by health institutions [1].

Table 2. The classification of waste generated by health care institutions.

DOMESTIC QUALITY WASTE (20 03* and 15 01*)		MEDICAL WASTE (18 01* and 18 02*)			HAZARDOUS WASTE	RADIOLOGICAL WASTE
A: General Waste **20 03 01***	B: Packaging Waste 15 01 01*, 15 01 02* 15 01 04*, 15 01 05*, 15 01 06*, 15 01 07*	C: Infectious Waste 18 01 03* and 18 02 02*	D: Pathological Waste 18 01 02*	E: Sharps Waste 18 01 01* and 18 02 01*	F: Hazardous Waste 18 01 06*, 18 01 08*, 18 01 10*, 18 02 05*, 18 02 07*	G: Radiological Waste

*Code numbers in European Waste Catalog of the European Union

The manager of a medical institution is obligated to educate the person concerned, such as medical health care and hospital waste workers, about the treatment of infectious waste. A control manager handling infectious waste should institute an education program and prepare a plan for the reduction and disposal of infectious waste materials [14].

As a result, due to the increase in the quantity and to the diversified quality of waste materials disposed of from medical institutions, the management of such materials has become increasingly important in order to protect medical staff, patients and waste workers from infection.

Some obligations of medical waste generators (health Institutions), and municipalities are listed below [1].

2.1.1. Obligations of medical waste generators

a) Building a system for minimizing waste at source,
b) Preparing and implementing an intra-unit waste management plan for separately collecting, transporting, and temporary storage of waste, comprising also measures to be taken in case of accident,
c) Collecting medical, hazardous, and domestic quality waste and packaging waste as well, all separately at source, without mixing with one another,
d) Using bags and containers responding to technical specifications as stipulated in this regulation for purposes of collecting medical waste and sharps waste,
e) Training, on a periodic basis, of personnel in charge of medical waste management,
f) Providing special clothing to personnel engaged in management of medical waste,
g) Keeping regular records of data on quantities of medical waste generated.

2.1.2. Obligations in terms of municipalities

a) Preparing, implementing, and informing public about the medical waste management plan,
b) Picking up medical waste at temporary storage locations and transporting the same to disposal site, or outsourcing the said operations,
c) Building and operating the facilities for disposal / sterilization of medical waste, or arranging for building and operation of the said facilities,
d) Obtaining preliminary license / license for disposal facilities and sterilization facilities that they plan to build / have other parties to build,
e) Training on a periodic basis, of personnel in charge of medical waste management.

The early studies concerning waste started in USA in 1967, originally in licensing and control procedures of laboratories. In addition to CDC

(Centers for Disease Control), installations like EPA (Environmental Protection Agency) and OSHA (Occupational Safety and Health Administration) prepared guide books regarding waste management [2].

Medical wastes are the ones generated during various medical activities. Like in all other sectors, the amount of medical waste is continually increasing and becoming a public health care problem and environmental risk. While 75-90% of the wastes resulting from health care services are harmless or do not pose any risk to public health, the rest are composed of risky, hazardous wastes, posing a serious threat to human and environmental health [14,11]. Medical wastes are sorted into groups by WHO (World Health Organization) such as infectious, pathological, sharps, genotoxic, pharmaceutical, heavy metal, pressurized containers and radioactive wastes. Collecting wastes after sorting them is very important for their suitably disposal [11].

In Turkey, waste management has been the subject of a number of legal arrangements starting from 1930's. Since then the number of institutions assuming role in the environmental field has increased [12]. The first studies in respect to waste control were arranged according to Environment Act No: 2872 of August 9, 1983 and Regulation for Control of Medical Waste, published in Official Gazette No: 21586, of 1993. With this regulation, while the task of disposing medical wastes were given to municipalities, generators of medical waste shall be obliged to pay the disposal service provider for the expenditures of collecting, transporting, and disposing of medical waste that they generate and Ministry of Environment would undertake the control responsibility [14].

A good waste management program should include all the phases of waste management. The main goal of waste management is, without doing any harm to human and environmental health, collecting, sorting, recycling and reutilizing these materials in the most economical way, and finally by reducing their amount and volume, disposing them safely. In respect to human and environmental health, the wastes generated in the hospitals do not only pose risks to hospital environment and patients, but also to the whole environment and public health [11, 14]. It is essential that medical wastes should not be mixed, collected and carried together with domestic wastes, be treated separately and specially. Unless wastes generated by health service aren't disposed correctly, they certainly create further risks [11].

As regards medical wastes, relevant medical staff, particularly doctors, nurses, midwives, dentists, and laboratory technical staff, should collect them at source as it is being generated, without mixing it with other categories of waste [2]. Under no circumstances, medical waste should be allowed to mix with domestic waste, or packaging waste, or hazardous waste. Packaging waste composed of paper, cardboard, plastic, or metal providing it has not been contaminated in any way, must be collected in blue-colored waste bags separately from other categories of waste [1].

Bags used in collecting medical waste shall be red-colored plastic bags resistant to tear, puncture, burst, and impact of transport; made of original medium intensity polyethylene material, with double-thread stitch in the bottom and without bellows, having *100 microns of double-layer thickness* and at least 10 kilograms of carrying capacity; also bearing, on both sides and in easily visible size, the "International Biohazard Symbol" and the expression "*Attention! Medical Waste*" Bags should be filled at most to ¾ capacity; strapped in the neck securely and, where necessary, each bag should be placed in another bag with the same properties and thus an absolutely certain state of non-leakage should be assured. These bags *(once used as such)* must not under any circumstances be recovered or reused. The contents of medical waste bags must not be compressed in any manner whatsoever, or emptied, or transferred to another container. Once any medical waste bag and sharps box has been filled to ¾ capacities it should be replaced with a new one immediately [1].

Medical sharps waste shall be placed, separately from other types of medical waste, inside boxes or containers made of plastic or laminated cardboard with similar properties, bearing on them the "International Biohazard Symbol" and the expression "*Attention! Medical Sharps Waste"* with such boxes or containers being resistant to puncture, tear, breakage, or burst, and also being waterproof, leak-proof, and impossible to either to open or to confuse with other boxes or containers. Medical sharps waste bags must be collected and carried within the unit by specially trained personnel by using suitable wheeled and lidded containers, allotted only for this job and made up from stainless metal, plastic or similar materials. Such waste containers should be filled to at most ¾ of their capacity, then closed securely and placed in red plastic bags. Once the sharps boxes are filled, they must not under any circumstances be opened, emptied, or recovered. Containers must be cleaned and disinfected every day, promptly after waste is removed or after any accident [1].

Disinfection, separated into three groups as high, medium and low level, is to eliminate pathogen microorganism from lifeless surfaces. As to

disinfectant, it is a chemical substance used to kill or eliminate pathogen microorganisms, but not expected to kill bacteria spores and viruses [12].

Cleaning staff assigned to transport of medical waste should be wearing, while at work, gloves, protective eyeglasses, boots, and orange-colored special protective apparel. Special apparel and gear as used in such transport should be kept in a separate location. Municipality, or other party to be commissioned by municipality, must have such apparel and gear cleaned [1]. In this research, it is aimed to carry out an investigation whether bacteriological growth occurs in waste bins which medical waste bags are put in.

3. MATERIALS AND METHODS

This study, carried out in health institutions in Sakarya, Turkey, aims to investigate whether the disinfection of medical waste bins which medical waste bags put in has been carried out effectively during the collection process. Authorized by the Sakarya Metropolitan Municipality, the contractor firm undertakes the task of collection, transportation, sterilization, disinfection, and treatment facilities in Sakarya Province.

In this study, the representative sample size for waste bin population was determined utilizing Krejcie and Morgan's Small-Sample Techniques (1960). In order to obtain the required sample size "Table for Determining Sample Size from a Given Population" was used. Our medical waste bin population given by the contractor firm authorized by the Sakarya Metropolitan Municipality was N=40128 waste bins for 4 months. In Accordance with the "Table for Determining Sample Size from a Given Population" at N=50000, the required sample size was 381 [13]. We used 580 Waste bins and nine of them could not evaluated, as a result, this procedure yielded a sample size of 571 (n=571). To eliminate the chance of selection error the population of waste bins, each waste bin was numbered for random selection.

Swab samples were taken from previously disinfected 571 medical waste bins located in a medical waste treatment facility authorized by the municipality. Samples were taken within 4 months, from February to May, nearly 143 samples on the monthly basis. The disinfectant used is chlorine dioxide (ClO_2) which is a powerful, selective oxidant and broad-spectrum biocide.

The features of the disinfectant used in medical waste bins' disinfection as follows:

a) The disinfectant used is ClO_2.
b) With each dosing pump, 180 ml/hour (total 360 ml/hour) dosing is made.
c) The washing process is started following measurement of 3.5 ppm using a measurement kit.
d) When 1 liter ClO_2 is diluted by adding 999 liters water, 40 ppm ClO_2 is obtained.

571 swab samples taken were sent to the labs of Sakarya University Education and Research Hospital Infection Diseases Clinics through transport medium. Swap samples were cultivated in 5% sheep blood agar, EMB agar and Chromagar Orientation Medium. It was checked whether there was any reproduction at 37ºC degree, after 18-24 hours of incubation. On the other hand, while collecting medical waste bags, the contractor company is still putting them straight in waste bins instead of putting them firstly in another non-used waste bag. After having collected medical waste bins from health institutions, the contractor company takes them to their sterilization unit and unloads them to containers for a proper sterilization in autoclave. These emptied bins should be disinfected properly in order to prevent any sort of contamination. Therefore, the contractor firm disinfects these emptied bins before delivering them to health institutions back.

4. RESULTS

The data in Table 3 were taken from Medical Waste Management Facility of Sakarya Metropolitan Municipality. According to the data in Table 3, the amount of medical waste disposed in 2011 and in 2012 was 1,114,679 kg and 1,223,150 kg respectively. Culture results of swab samples were taken from 571 medical waste bins were evaluated. The mentioned 571 swab samples taken within 4 months were incubated and determination of types was made in growing samples. While the samples in which at least one type of bacteria grew were considered positive, the samples with no bacteria growth were considered negative.

Table 3. Distribution of medical waste amounts per year in Sakarya province.

Area Number	Area	2011	2012
	Sakarya Province	Amount (kg)	Amount (kg)
1	Metropolitan Municipality	583.253	635.396
2	Boundaries out of Municipality	33.128	38.968
Total		616.381	674.364
3	Düzce Province	242.614	290.546
4	Bolu Province	255.684	258.240
General Total		1.114.679	1.223.150

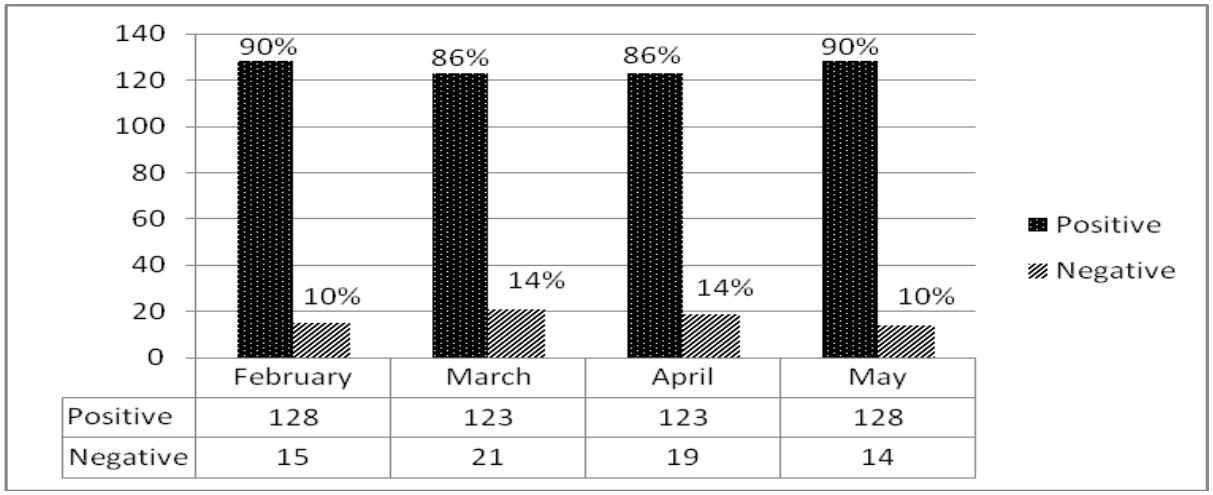

Figure 1. The culture results of swab samples in respect to 4 months.

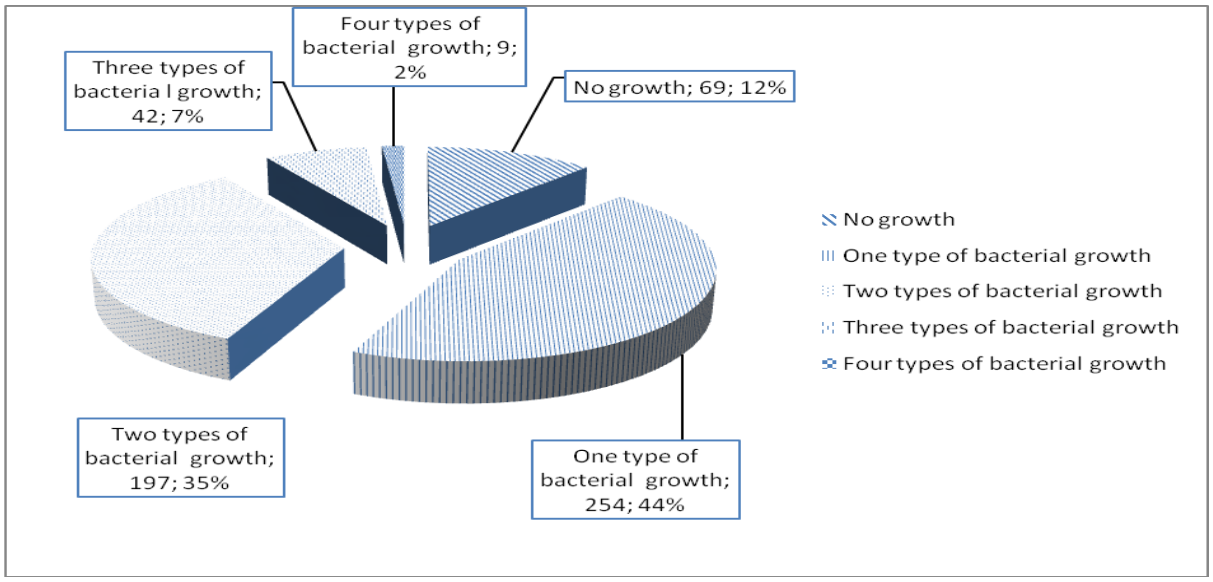

Figure 2. The bacterial growth in respect to the types of bacteria.

From growing numbers and percentages in Figure 1, it is seen that 90% of 143 bacterial incubation samples in February is positive, 86% of 144 samples of bacterial cultivation in March is positive, 86% of 142 bacterial cultivation samples in April is positive, and 90% of 142 bacterial cultivation samples in May is positive.

Figure 2 shows the bacterial growth in respect to types of bacteria. As seen in figure 2, no growth was determined in 69 (12%) bacterial cultivation samples; In 254 samples, only one type of bacterial growth was seen (44%). These were: Enterococcus faecalis:125; Escherichea coli:9; Klebsiella pneumoniae:84; Staphylococcus aureus:32; Staphylococcus saprophyticus:1; Proteus spp:3; In 197 samples, two types of bacterial growth was seen (35%).In each couple of bacteria, one is: S. Aureus:75; E. faecalis:118; E. coli:109; K. pneumoniae:91; Proteus spp:1; In 42 samples, 3 types of bacteria grew (7%). These were E. Faecalis, E. coli, K. pneumoniae, S. Aureus; In 9 samples, 4 types of bacteria grew (2%). These were E. Faecalis, E. coli, K. pneumoniae, S. Aureus.

5. DISCUSSION

All wastes generated from health institutions are called as hospital waste and they are one of the major factors causing environmental contamination. Such wastes pose risks to employees, patients and to community health care. Medical waste bags should be collected and carried within the unit by specially trained personnel by using suitable wheeled and lidded vehicles. The cleaning staffs handling these medical wastes have to wear gloves, eye protection, mask, boots and special orange-colored protective garments. In 502 samples out of 571, growth was observed and among these reproducing bacteria were E. faecalis, E. coli, K. pneumoniae, S. aureus, Proteus spp and S. Saprophyticus, most of which cause nosocomial infections. As a result, there is a risk for patients and also different levels of hospital staff from administrators and top managers to doctors and nurses, down to waste handlers and maintenance and disinfection operations staff.

In hospitals, recently witnessing a struggle against vancomycin-resistant *enterococcus* and methicillin-resistant *S. aureus* and ESBL (+) *K. pneumonia* and *E. coli*, reproduction of bacteria in medical waste bins is a serious problem. In conclusion, it is very important for the related-staff to conform standard infection prevention measures in hospitals. Not only the staff handling these medical wastes but also all the other health care staff and patients are at risk. Therefore, all related institutions should be warned about taking necessary precautions and about the appropriate disinfection of medical waste bins.

Health institutions generating medical waste are responsible for making these wastes harmless. For a proper management of medical waste generated by health institutions, medical waste management team should contain chief physician, heads of the departments, infection control officer, chief pharmacist, radiation officer, head nurse, hospital manager, hospital service director, working capital director and waste management officer. However, each member of this medical waste management team should duly perform his/her duty. Moreover, this team should make sure that medical waste bins delivered to the hospital are disinfected properly and control this process by making cultivations in the related service of the hospital on a monthly basis. During and after disinfection operation, measures shall be taken to assure that there would not be any contamination in medical waste bins.

The objectives of a waste management scheme should be to change a mindset through training. Standard training modules for doctors, nursing staff, laboratory technicians, ward attendants, patients and their attendants should be developed to create awareness and ensure efficient handling and management of medical waste.

Ongoing evaluation of the medical waste management program in the hospital is very important to identify bottlenecks and to take remedial action. The aim should be to make improvements and gradually move towards a sustainable system in order to achieve a healthier environment, mind and body.

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