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An analysis of trends related to hospital solid wastes management in Kuwait

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Abstract

Purpose – The purpose of this paper is to determine the amount of different kinds of solid wastes produced, segregated, collected, stored, transported and disposed off in the governmental hospitals of Kuwait.

Design/methodology/approach – The research in this paper shows that all governmental hospitals were assessed in a period of six months (September, 2005 through December, 2005 and June, 2006 through July, 2006). The weight fraction of each component in the sorting sample was calculated by the weights of the components. The amount of non-infectious and infectious waste generated in kg/day in each ward and various hospital blocks were determined and recorded.

Findings – The findings in this paper indicated that the waste generation rate is between 3.87 kg/bed/day and 7.44 kg/bed/day. Subsequently, this waste consists of 10,534.5 kg (71.44 percent) of domestic waste, 4,099.4 kg (27.8 percent) of hazardous/infectious waste, and 112.1 kg (0.76 percent) of sharps. Hospital waste makes up approximately 30 percent of all the hazardous waste generated in Kuwait. Segregation of the different types of wastes is practiced in nearly all of the hospitals. All infectious/medical wastes are finally disposed of through incineration.

Practical implications – The paper shows that the hospitals under study do not organize training courses on hospital waste management and the hazards associated with them. There is a need to establish a detailed database regarding the quantity and quality of the waste generated by the various hospitals.

Originality/value – This paper systematically assesses the obstacles in the existing hospital solid waste management system in all governmental hospitals in Kuwait. Subsequently, recommendations and improvements are suggested.

Keywords Waste, Incineration, Kuwait, Waste management, Hospitals

Paper type Research paper

Introduction

Background information about Kuwait

Covering an area of 17,818km^2, Kuwait lies in the northwestern corner of the Arabian Gulf. Kuwait mainland extends between latitudes 28° 30′ and 30° 06′ north, longitudes 46° 30′ and 48° 30′ east, and measures about 200 km from the farthermost northern to the farthermost southern points and about 170 km from east to west between the extreme longitudes.

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Because of its high per capita income ($16,800), comparable with those in Western European countries, Kuwait provides its citizens with extensive health care, educational, and retirement benefits. In 2005 the per capita gross domestic product (GDP) was $19,200 and the growth rate of it was 4.8 percent. The gross national product (GNP) was $21,802 and the average annual growth of the GNP per capita − 3.5 percent.

The State of Kuwait consists of six governorates. The registered population of the country as of the year 2005 is 2.42, million and population density is 140 per km^2. About 0.83 million are Kuwaiti citizens and 1.59 million are non-Kuwaitis. The population growth rate is reported to be 6.25 percent per year. The infant mortality rate is 9.71 deaths per 1,000 live births, and the average life expectancy is 77.2 years (MOP, Ministry of Planning, 2005). All medical care in the public/governmental hospitals in Kuwait is free for citizens and minimal for non-citizens. Kuwait has a total of 16 governmental hospitals with a total of approximately 4,894 beds.

General information

Industrial and economic advancements and urban growth together with increases in population and population density have resulted in an increase of per capita waste production since late 1970s and early 1980s. Hospital waste is special in that it has a higher potential for infection and injury than other types of wastes. Clinical waste is generated during the diagnosis, treatment or immunization of human beings or animals as well as in research activities in these fields, and in the production or testing of biological samples. It may include wastes like sharps, solid waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminating manner.

There is no single definition of "medical waste". The terms medical wastes, hospital wastes, and infectious wastes have often been used interchangeably. The World Health Organization (WHO, World Health Organization, 1997) has classified medical waste into different categories. These are:

- *Infectious*: material-containing pathogens in sufficient concentrations or quantities that, if exposed, can cause diseases. This includes waste from surgery and autopsies on patients with infectious diseases;
- *Sharps*: disposable needles, syringes, saws, blades, broken glasses, nails or any other item that could cause a cut;
- *Pathological*: tissues, organs, body parts, human flesh, fetuses, blood and body fluids;
- *Pharmaceuticals*: drugs and chemicals that are returned from wards, spilled, outdated, contaminated, or are no longer required;
- *Radioactive*: solids, liquids and gaseous waste contaminated with radioactive substances used in diagnosis and treatment of diseases like toxic goiter; and
- *Others*: waste from the offices, kitchens, rooms, including bed linen, utensils, paper, etc.

Infectious wastes have been described as "biohazardous", "health-services hazardous", "pathological", "biological", "hazardous infectious" (Lee *et al.*, 2002, 2004).

Hospital waste generation depends on numerous factors such as established waste management methods, type of health-care establishment, hospital specializations, proportion of reusable items employed in health care, and proportion of patients treated on a day-care basis. In middle and low-income countries, health-care waste generation is usually lower than in high-income countries. The amount of radioactive health-care waste is generally extremely small compared with the radioactive waste produced by the nuclear industry.

It is now commonly recognized that certain categories of medical waste are among the most hazardous and potentially dangerous of all wastes generated in a community (DEFRA, Department for Environment, Food and Rural Affairs, 2005; Karademir, 2004). As the volume and the complexity of healthcare waste increase, the risk of transmitting disease through unsafe handling and disposal practices also increases. The recent rise (since late 1980s) in the incidence of such diseases as AIDS, and Hepatitis B and C opens up the possibility of infection of the personnel handling these wastes, and risks to public health arising from the transport of infectious and hazardous wastes (Almuneef and Memish, 2003). There is growing awareness worldwide of the need to impose stricter controls on the handling and disposal of wastes generated by healthcare facilities (DEFRA, Department for Environment, Food and Rural Affairs, 2005). This is an extension of the common concern for hospital hygiene and should be an integral part of hospital management.

Today, collection, transport and disposal of wastes have turned into a complicated and important problem that needs to be regulated by definitive rules. This issue is so important that in many industrialized countries, specific rules and regulations have been implemented for medical institutions, regardless if they belong to the public or to the private sector (Diaz *et al.*, 2005).

Biomedical waste management is a special case wherein the hazards and risks exist not just for the waste generators and operators, but also for the general community (Sandhu and Singh, 2003). Hence, collection and disposal of waste in the proper manner is of great importance as it can alleviate health risks to people both directly and indirectly, and reduce damage to flora, fauna, and the environment (Centers for Disease Control and Prevention, 2001). Healthcare workers are exposed to blood and other body fluids as part of their day-to-day activities at the healthcare facilities. As such, healthcare workers face the risk of infection due to blood or other liquid borne pathogens. There are several pathways for the transmission of disease to healthcare workers. Some of the most important pathways are: injuries with contaminated sharps (through the skin), contamination through the fecal-oral route (e.g. salmonellosis, hepatitis A), and contamination through airborne transmission (e.g. tuberculosis, measles). Skin injuries by sharp account for 66-95 percent of all occupational exposures to blood borne pathogens (CCOHS, Canadian Center for Occupational Health and Safety, 2000; Puro *et al.*, 2001; Romea *et al.*, 1995). Skin injuries from needles account for 62-91 percent of injuries by sharps (NaSH, The National Surveillance System for Hospital Care Workers, 1999; Puro *et al.*, 2001; Romea *et al.*, 1995).

An effective and efficient program for the management of healthcare wastes is a critical component of the facility's infection control program and consequently plays an

important role in the quality of care, as well as in the occupational health of the entire staff of the facility.

Waste management has become a critical issue as it poses potential health risks and damage to the environment, which has taken a central place in the national health policy and is attracting a considerable international interest.

Materials and methods

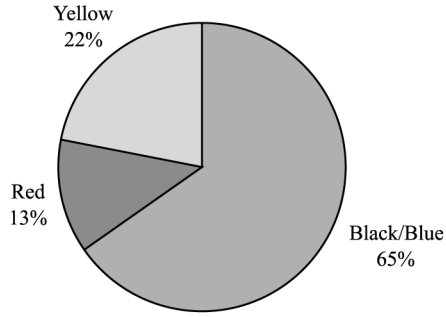
All medical care in the public/governmental hospitals in Kuwait is free for citizens of Kuwait. However, for expatriates, it is minimal it costs about US$7 per visit. Kuwait has a total of 16 governmental hospitals with a total of about 4,894 beds. Eight of these hospitals have been built mainly within Al-Sabah Medical Center. In addition, Kuwait has six private hospitals with a total of about 600 beds. All governmental hospitals are shown in Table I. Private hospitals charge patients (Kuwaitis and non-Kuwaitis) special fees. The fees charged by private hospitals are much higher than those the public hospitals charge. On the other hand, patients in poor or difficult conditions are not admitted in these private hospitals because of the limited number of wards and services to cover patients, so these hospitals have a special status. Recently, the government has approved the construction and addition of nine new hospitals with a total of 5,930 beds, to be ready in 2010.

In this study all existing governmental hospitals were assessed in a period of six months (September, 2005 through December, 2005 and June, 2006 through July, 2006). Nearly 33,000 metric tons of medical waste is generated by governmental and private hospitals in Kuwait every year with about 10-15 percent of all the waste classified as infectious waste. These quantities represent about 31 percent of the total hazardous solid waste generated in the country. The loads of waste were designated for sampling, and a sorting sample was collected from the storage/collection area. The sample was sorted manually into waste components. The weight fraction of each component in the sorting sample was then calculated. The mean waste composition was calculated using the results of the composition of each of the sorting samples. The amount of non-infectious and infectious waste generated in kg/day in each ward and various blocks was determined and recorded for each day over the six-month period. Projections for the average quantity of various types of waste generated for one month and for one year were determined from these data. The typical percentages of non-infectious and infectious types of waste generated from various public/governmental hospitals in Kuwait are shown in Figure 1, in which the color

Hospital	Number of beds
Al-Sabah	325
Al-Amiri	374
Al-Adan	521
Mubarak Al-Kabir	409
Al-Farwanya	425
Al-Jahra	420
Al-Sabah Medical Center	1,983
Psychiatry	456
Ibin Sina	306

Table I. Governmental hospitals in Kuwait and their number of beds

of the bag signifies whether the waste is infectious or not (Table II). The composition in percentage of non-hazardous wastes generated is shown in Figure 2. The wet wastes generated in the hospital kitchens and restaurants, and the soiled cloths sent to the laundry were not included in the study.



Note: Black/blue bags; non-infectious and non-hazardous waste, Red bags; human anatomical waste, body fluids etc., Yellow bags; waste sharps

Figure 1.
Typical type and percentage waste from public/governmental hospitals in Kuwait according to color of bag

Color coding of polyethylene bag	Type of waste material collected
Black/blue	Non-infectious and non-hazardous waste (e.g. food remains, cardboard, paper, wood, etc.)
Red	Human anatomical waste, items contaminated with blood and body fluids, and waste generated from disposable items other than sharps, rubber gloves and tubing, tissues and bandage, drop-bags, medical remains, scalpels, infectious and pathological waste from the patients, blood plasma remains, cloth, etc.
Yellow (puncture proof)	Waste sharps, surgical needles, microbiological waste from pathological laboratory, items contaminated with blood and body fluids, and waste generated

Table II.
Segregation of bio-medical solid waste at hospitals in Kuwait

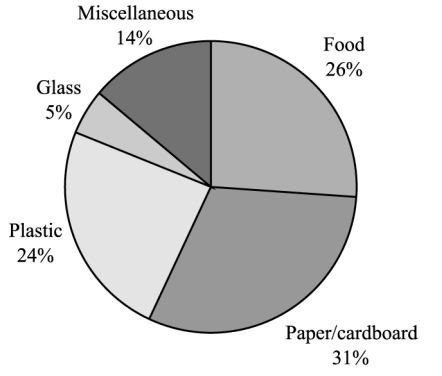


Figure 2.
Typical composition of non-hazardous wastes at public/governmental hospitals in Kuwait

Results and discussion

Operation assessment

Observations concerning waste collection were made during the waste handling process and questions were asked to the staff in charge regarding the care taken in the handling of the wastes. The explanation given by staff was that they were handling biohazardous materials and that if they were careless it could be injurious to them and to others, and also could cause the spread of infectious diseases. The staff further added that there could be serious ramifications on the human health in the community, which might spread to a larger area. It is worth to mention that the general situation and procedures reported in this section and sections 3.2 and 3.4 are the same in all public/governmental hospitals.

Segregation aspects

The waste was segregated according to its characteristics at the point of generation, mainly from the patient care areas. Anatomical parts that are attached to the bones are given to the patients' next of kins and are buried according to religious rites. In the cases where bones are not attached to the anatomical parts, the parts that have been removed are considered to be infectious wastes. The hospitals use color-coded, high-density polyethylene bags (at least 80 micron thick) for easy identification and segregation of bio-medical solid waste. Non-infectious and domestic type of wastes were collected in black, blue or white polyethylene bags and placed in bins. The infectious wastes were collected in red and yellow color-coded high-density polyethylene bags labeled with a bio-hazardous infectious material symbol and then placed in specific bins. The details of the segregation of the waste in the containers are shown in Table II.

Both types of wastes were collected twice a day, once in the morning before 8am and once in the evening before 6pm. The waste from the Operation All containers kept for the collection of hazardous wastes were labeled with biohazard/cytotoxic symbols while other containers for non-hazardous wastes were not labeled.

Generation rates

Non-hazardous wastes. General waste produced at the hospital is related to food preparation, administrative departments, and landscaping. This type of waste is similar to household waste and/or municipal waste. Using sampling techniques, the amount of total waste produced at the different hospitals in Kuwait was obtained. The total wastes varied between 3.87 kg/bed/day and 7.44 kg/bed/day, which includes 10,534.5 kg (71.44 percent) of domestic waste, 4,099.4 kg (27.8 percent) of hazardous/infectious waste, and 112.1 kg (0.76 percent) of sharps. However, the amounts of non-hazardous waste varied between 1.91 kg/bed/day and 4.59 kg/bed/day. A maximum amount of 14,746 kg/day of total solid waste was generated at the Sabah Medical Center while a minimum amount was produced (820 kg/day) at Al-Sabah Hospital. Figure 2 indicates that the major component of the wastes was paper and cardboard, followed by food waste. Total organic wastes amounted to more than 55 percent at the hospitals showing that a biological treatment method such as composting would be suitable to treat these wastes. In addition, paper/cardboard, plastic and glass could be recycled. Furthermore, recycling can benefit a community greatly both by generation of employment opportunities and utilization of resources.

Hazardous wastes. In the hospitals, different kinds of therapeutic procedures such as cobalt therapy, chemotherapy, dialysis, surgery, delivery, resection of gangrenous organs, autopsy, biopsy, para-clinical exams, injections, etc. are carried out and result in the production of infectious wastes, sharp objects contaminated with patients' blood and secretions, radioactive wastes and chemical materials which are considered to be the hazardous wastes (Pruss *et al.*, 1999). The amount of waste generated in the hospitals depends on various factors such as the number of beds, types of health services provided, economic, social and cultural status of the patients, and the general condition of the area where the hospital is situated. From the pre-assessment and the material balance phases, the amount of hazardous and non-hazardous wastes generated from all public/governmental hospitals are as shown in Figure 1 accounting to the color of the bag.

The hazardous wastes generation varied between 0.63 kg/bed/day at Al-Amiri hospital and 2.28 kg/bed/day at Al-Farwania hospital. The waste generation rates compare to general values obtained in other countries as indicated in Table III. In Japan, the hazardous waste generation rate, on an average, is 0.471 kg/bed day, while the net medical waste generation rate is between 1.5 and 3.0 kg/bed day. In addition, the waste generation rate in Kuwait is much lower than that of 4.5 kg/bed/day in the USA, 4.0 kg/bed/day in Spain, 4.4-6.1 kg/bed/day in Jordan and 3 kg/bed/day in France. However, the average hospital waste generation rates in Mexico, Saudi Arabia, Bangladesh, Venezuela and Argentina are between 1.05 kg/bed/day and 1.5 kg/bed/day. The pattern in hazardous waste generation is similar to domestic wastes where industrialized countries have higher rates. The waste generation rate in Dar es Salaam (Tanzania) hospitals was reported to be between 0.84 and

Table III.
Average waste generation rate at hospitals in different countries

Country	Waste generation rate (kg/bed/day)	Reference
Kuwait	3.87-7.44	This study
Jordan	4.01-6.1	Bdour *et al.* (2006)
Saudi Arabia	1.1	Al-Zahrani *et al.*, 2000
UAE	3.9	Shuwaiter (1995)
Iran	4.2-21.1	Askarian *et al.* (2004); Karamouz *et al.* (2006)
Turkey	1.92-2.01	Karaka (2002)
Japan	1.5-3.0	Tanaka *et al.* (2003)
India	0.5-2.0	Patil and Shedkar (2001); Patil and Pokhrel (2005)
Thailand	0.11-0.65	Waste Not Asia (2001)
Bangladesh	1.2	Rahman *et al.* (1999)
France	3.3	USA, EPA (2002)
Argentina	1.5	Rahman *et al.* (1999)
Tanzania	0.14	Askarian *et al.* (2004)
Norway	3.9	USA, EPA (2002)
Mauritius	0.398-0.478	Mohee (2005)
Spain	4.4	USA, EPA (2002)
Mexico	1.05	Rahman *et al.* (1999)
Brazil	3.245	Silva *et al.* (2005)
Venezuela	1.45	Rahman *et al.* (1999)
The United Kingdom	3.3	USA, EPA (2002)
The US and Canada	1.5-3.9	Mato and Kassenga (1997)

5.8 kg/bed/day (Mato and Kassenga, 1997). The results of our study corresponded with the report by the WHO regarding the waste generation rate in general hospitals (Askarian *et al.* 2004; Pruss *et al.*, 1999).

Collection, storage and transportation

The collection of infectious and non-infectious wastes was undertaken by two teams of two members each, one for pulling the cart and distributing empty polyethylene bags (at least 80 micron thick) and the other member for sealing the bags, putting the bags into the cart and replacing the bins with polyethylene bags. This procedure was observed in four of the public/governmental hospitals (Al-Sabah, Al-Sabah Medical Center, Al-Farwanya and Mubarak Al-Kabir) in these case studies. The staff was aware of the potential hazards of the material they were handling and were found to take requisite protective measures. They wore impervious gloves and masks during collection of infectious wastes, segregation of various color-coded containers and transporting wastes in the designated cart, taking adequate precaution to prevent any spillage from the plastic bags. Cleaners and nursing assistants were responsible for collection, internal storage and transport to external storage of the medical wastes. The bio-medical solid wastes were not stored for more than 18 hours off-site. The bins in the wards were strictly placed away from patients and from the nursing station. The place where the hospital waste is kept before transporting to the final disposal site is termed as a temporary waste storage area. This area must be well sanitized and secured in such a way that it should be accessible only to authorized persons (Pruss *et al.*, 1999). Almost all hospitals have well sanitized and secured temporary storage areas. The infectious and non-infectious waste are kept in separate containers and are not mixed together in the hospital's own temporary storage area.

Final disposal of waste

Non-infectious waste. A private company at each hospital is engaged on collection, treatment and final disposal of all wastes. The separately collected and transported non-infectious waste is put in the large municipal bins to be removed daily and dumped in the municipal waste landfills.

Treatment of infectious biomedical solid waste. The final disposal of infectious biomedical waste is carried out by incineration. There is one central incinerator unit in Kuwait and it is located in the south of the country (Mina Abdulla). It is equipped with two chambers and a dry scrubber with design capacities between 350 and 850 kg/hour. Waste is fed into the primary chamber by an automatic hydraulic system.

Primary combustion chamber. The primary combustion chamber consists of a refractory lined steel construction equipped with a furnace door on the top and one or two ash conveyors at the bottom (automatic de-ashing version only) or, in case of manual de-ashing – a flat hearth bottom. For heating up the primary chamber an oil- or gas burner is mounted. The waste is fed into the primary chamber, where it is heated by the refractory walls and by means of the primary burner, regulated by the temperature. In the primary combustion chamber, the gases are out burning for approximately two seconds at either 850°C or 1,100°C depending on the waste composition and requirements.

The primary chamber is equipped with air nozzles for the supply of combustion air, controlled and regulated by the control system. The heavy particles are out burned by

means of the heat and supply of combustion air through jet tube pipes at the hearth bottom in the walls and before entering the secondary chamber. As mentioned above, the primary combustion chamber is, in the automatic de-ashing version, at the bottom equipped with two ash conveyors, which automatically rotate the waste for out burning and also transport the ash to the ash chamber, where the final out burning takes place. The ash continues to the ash hopper and the ash container.

Secondary combustion chamber. Gases and burnable light soot particles are at the inlet to the secondary chamber led through a mixing zone, where they are mixed with air for out burning. In the secondary combustion chamber, the gases are turbolating and out burning for approximately two seconds at 850°C, 1,100°C or 1,200°C depending on the waste composition and requirements.

The secondary combustion chamber is equipped with modulated oil burner or gas burner for regulation of the temperature to optimise burning of the flue gases.

Flue gas cooling system. In order to cool down the flue gases, a specially designed boiler system is implemented in the incinerator line. The system features two solutions: Hot water boiler system (standard); where the heat from the flue gases can be utilized for central or district heating or, in case such a solution is not feasible, the hot water can be cooled in a cooling tower and Steam boiler system (optional); where the heat from the flue gases can be utilized as steam for industrial purposes or for generating electric power in combination with a single- or multistage turbine. The incinerator is capable of removing the following substances:

- particles;
- gaseous and vaporous organic substances expressed as Total Organic Carbon TOC;
- hydrochloric acid HCl;
- hydrogen fluoride HF;
- sulphur dioxide SO_2;
- dioxins and furans; and
- heavy metals and their compounds.

Ash chamber. The primary combustion chamber is in the back designed with an ash chamber and an ash chute, which is provided with a tight sealed ash container. The ash conveyors transport the ash from the primary chamber to the ash chamber, where it is cooled down by the temperature of the conveyors, before it is transported down in the ash hopper and to the sealed connected ash container. The ash container is connected to the ash chute with quick-clamp-handle for easy and tight mounting.

The ash generated in the incinerator is removed from the incinerator every day and stored outside the incinerator room. Periodically, after accumulation of a sufficient quantity of ash, the material is transported to be dumped in the industrial sanitary waste landfill.

The operation of the incinerators follows a daily cycle consisting of:

(1) Removal of residual ash from the incinerator in the morning.

(2) Start-up, ignition and initial burning up to the firing temperature.

(3) Loading of waste into the incinerator as it arrives.

(4) Burning down waste in the incinerator.

The last load of bio-medical waste that is charged in the incinerator in a particular day is fed at least two hour prior to start of the cooling cycle so that no part of the bio-medical waste is left unburned.

Incinerator location and its operation

The incineration process destroys pathogens and reduces the volume of waste by 95 percent and its weight by 75 percent. In the past there used to be, an incinerator in every public/governmental hospital in Kuwait. Incinerators used to be located at the rear of the hospital, separated from the main building with sufficient space for easy movement of the trolleys and vans carrying the waste directly into the room where the segregated solid biomedical waste could be unloaded for incineration. However, some of the incinerators were very old and not operated efficiently. Therefore, the Ministry Of public Health (MOH) replaced all the incinerators with one central unit in the south of the country (Mina Abdulla). One specialized company is responsible for collecting and transporting the hospital/hazardous wastes to the incinerator. The incinerator is designed with automatic de-ashing ensuring a fully automatic operation either intermittently or continuously 24 hours a day, with low operational and maintenance costs. It was observed that MOH was extending its incineration facility at a very nominal price to the clinics and nursing homes in Kuwait city and in nearby areas with a dedicated team of staff for transport and collection of biomedical wastes for incineration at its site, once a day, everyday. The operating conditions were found to be well-monitored with periodic checks of the temperature of incineration as per the EPA 1998 and the European emission regulations (Directive, 2000/76/EC) rules. Hospitals have been rendering their services since June 2001 and until the date of the study period, no complaints had been made.

Conclusion and recommendations

Nearly all the hospital facilities studied promote segregation of medical/hazardous wastes. However, not much attention is given to the other types of wastes such as paper/cardboard, plastic, glass, etc. which are usually managed without a perspective for recycling and are collected through the municipal collection system. The total wastes varied between 3.87 kg/bed/day and 7.44 kg/bed/day. However, the amounts of non-hazardous waste varied between 1.91 kg/bed/day and 4.59 kg/bed/day. Moreover, the hazardous wastes generation varied between 0.63 kg/bed/day at Al-Amiri hospital and 2.28 kg/bed/day at Al-Farwania hospital. A maximum amount of 14,746.0 kg/day of total solid waste was generated at the Sabah Medical Center while a minimum amount was produced (820 kg/day) at Al-Sabah Hospital. Subsequently, the following recommendations are suggested:

- A comprehensive performance study throughout the country should be considered for the compilation of a necessary rules and establishing standards in this field along with planning regular and effective training programs.
- Periodic meetings should be conducted involving administrative and maintenance staff who are directly or indirectly involved with waste management in order to share and discuss the technical or practical difficulties, and provide suggestions that may be specific to a particular hospital and region.

Finally, a compulsory training program should be conducted for all new staff in the hospital to familiarize them with the operating procedures practiced in the hospital.

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