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Introducing a new medical waste tracking and classification system for Jordan

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Abstract

Purpose – The purpose of this paper is to introduce a cradle to grave manifest system for medical waste in Jordan. As part of this program, medical waste classification, generation rates, and tracking in different parts of the world and in Jordan are described.

Design/methodology/approach – After reviewing different classification systems, the program adopted the World Health Organization definition with minor modification to be used with the proposed manifest, as it is very similar to the current bylaw regulating medical waste in Jordan. In addition, the generation rates of hazardous medical waste in 11 public hospitals and one governmental university hospital in the northern part of Jordan were calculated. These were based on the weights of these wastes that were transferred to the sole incinerator used by these hospitals over a 12-month period. These weights were obtained through interviews with personnel in charge of the medical waste incinerator.

Findings – This project has devised a manifest form to be used for medical waste transport. In addition, the generation rate was found to vary from 0.88 to 3.05 kg/bed/day based on 100 percent occupancy rates. The generation weight was found to be different for different months of the year.

Originality/value – Management of waste disposal and treatment, including medical waste is very important in a water poor country like Jordan. The introduction of a manifest system and the adoption of a medical classification system, in addition to the calculation of the generation rates are very important for sustainable development in the country.

Keywords Jordan, Hospitals, Waste disposal, Medical waste classification, Medical waste generation rate, Medical waste manifest

Paper type Case study

1. Introduction

Health-care wastes or medical wastes are defined differently in different parts of the world (Prüss *et al.*, 1999; European Waste Catalogue (EWC), 2001; Miyazaki and Une, 2005; Ananth *et al.*, 2010; United States Environmental Protection Agency, 2013). For example, the European Union defines medical wastes as wastes from human or animal health-care and/or related research (EWC, 2001). The World Health Organization (WHO) defines medical waste as the waste generated by health-care establishments, research facilities, and laboratories, in addition to waste originating from "minor" or "scattered" sources (Prüss *et al.*, 1999). According to the United States Environmental Protection Agency (2013) medical wastes contain all waste materials generated by health-care facilities, such as hospitals, clinics, physician's offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as at medical research facilities and laboratories. In addition, many countries have adopted their own classification of medical waste.

As Jordan is in the process of introducing a manifest system for tracking of medical waste from cradle to grave, it is necessary to adopt a national classification of medical waste that could be used as a basis for tracking of such waste. Medical waste has been classified by international agencies such as the WHO, Basel Convention, or the United Nations (UN). In addition, many countries have adopted their own classification of

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medical waste, and therefore one should also review these classifications. When deciding on a particular classification, one should consider local social and economic conditions. The following is a review of the international bodies' classification of medical waste, and classifications being adoptive by different countries.

WHO classification

The WHO classifies medical waste into nine categories. Table I gives a brief description of such categories (Prüss *et al.*, 1999).

Basel Convention classification

Basel Convention is an international treaty that regulates the trans-boundary movements of hazardous wastes. According to the Technical Guidelines on Environmentally Sound Management of Biomedical and Health-care waste provided by the Conference of the Parties to the Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste and their Disposal, health-care wastes are classified as shown in Table II (Secretariat of the Basel Convention, 2003).

UN Classification

According to the "Recommendations on the Transport of Dangerous Goods" (UN, 2007), infectious substances that fall under Hazard Class (Division) 6.2 are defined as "substances which are known or are reasonably expected to contain pathogens." It also

Waste category	Remarks
Infectious waste	Cultures and stocks of infectious agents from laboratories, waste from surgery and autopsies on patients with infectious diseases, tissues, and materials or equipment that have been in contact with blood or other body fluid, etc.
Highly infectious waste	This is a subcategory of infectious waste according to WHO classification. This category includes cultures and stocks of highly infectious agents, waste from autopsies, animal bodies, and other waste items that have been inoculated, infected, or in contact with such agents
Pathological waste	Tissues, organs, body parts, human fetuses and animal carcasses, blood, and body fluids, anatomical waste
Sharps	Needles, hypodermic needles, scalpel and other blades, knives, infusion sets, saws, broken glass, and nails
Pharmaceutical waste	Expired, unused, spilt, and contaminated pharmaceutical products, drugs, vaccines, and sera. The category also includes discarded items used in the handling of pharmaceuticals
Genotoxic waste	Cytostatic drugs, vomit, urine, or feces from patients treated with cytostatic drugs, chemicals, and radioactive material. Cytotoxic drugs are used in chemotherapy of cancer
Chemical waste	Discarded solid, liquid, and gaseous chemicals, for example from diagnostic and experimental work and from cleaning, housekeeping, and disinfecting procedures
Waste with high content of heavy metals	Mercury from thermometers, blood-pressure gauges, residues from dentistry, etc. Cadmium waste comes mainly from discarded batteries. Certain "reinforced wood panels" containing lead, are still used in radiation proofing of X-ray and diagnostic departments
Pressurized containers	Many types of gas are often stored in pressurized cylinders, cartridges, and aerosol cans. Pressurized containers may explode if incinerated or accidentally punctured
Radioactive waste	Produced in the analysis of body tissue and fluid, organ imaging and tumor localization, and various investigative and therapeutic practices

Table I.
WHO classification of medical waste

Waste category	Sub-categories (groups)
A. non-risk HCW This includes waste that has not been infected which is similar to normal household or municipal waste and can be managed by the municipal waste services	A1 Recyclable waste: paper, cardboard, non-contaminated plastic or metal, cans or glass A2 Biodegradable waste left over food or garden waste A3 Other non-risk waste: all the non-risk waste that do not belong to categories A1 and A2
B. Biomedical and health-care waste requiring special attention	B1 Human anatomical waste B2 Waste sharps B3 Pharmaceutical waste B4 Cytotoxic pharmaceutical waste B5 Blood and body fluids waste: wastes that are not categorized as infectious waste but are contaminated with human or animal blood, secretions and excretions
C. Infectious and highly infectious waste Infectiousness is one of the hazard characteristic listed in Basel Convention and defined under class H6.2	C1 Infectious waste: this class has the potential of transmitting infectious agents to humans or animals C2 Highly infectious waste: it includes microbiological cultures in which a multiplication of pathogens has occurred and cultures and stocks of laboratories
D. Other hazardous waste	Chemicals, waste with high contents of heavy metals, pressurized containers, etc. Examples of such wastes include thermometers, blood-pressure gauges, photographic fixing and developing solutions in X-ray departments, halogenated or non-halogenated solvents, organic and in-organic chemicals
E. Radioactive health-care waste	This includes liquids, gases, and solids contaminated with radionuclides whose ionizing radiations are genotoxic

Table II.
Classification of medical waste according to Basel Convention

defines medical or clinical wastes as "wastes derived from the medical treatment of animals or humans or from bio-research."

Infectious substances. Infectious substances are divided into the following categories according to UN classification:

Category A: an infectious substance which is transported in a form that, when exposure to it occurs, is capable of causing permanent disability, life-threatening or fatal disease in otherwise healthy humans or animals. Infectious substances meeting these criteria which cause disease in humans or both in humans and animals shall be assigned to UN 2814. Infectious substances which cause disease only in animals shall be assigned to UN 2900 (Table III).

Category B: an infectious substance which does not meet the criteria for inclusion in Category A. Infectious substances in Category B shall be assigned to UN 3373. The proper shipping name of UN 3373 is "Biological Substance, Category B" (Table III).

Medical or clinical wastes. Medical or clinical wastes containing Category A infectious substances are assigned to UN 2814 or UN 2900 as appropriate. Medical or clinical wastes containing infectious substances in Category B shall be assigned to UN 3291. Medical or clinical wastes which are reasonably believed to have a low probability of containing infectious substances shall be assigned to UN 3291. The proper shipping name for UN 3291 is "Clinical waste, unspecified, n.o.s or (Bio) Medical waste, n.o.s., or Regulated medical waste, n.o.s." (Table III).

Hazardous materials descriptions and proper shipping names	Hazard class or division	Identification numbers	Label codes
Corrosive solids, nos	8	UN1759	8
Corrosive liquids, nos	8	UN1760	8
Medicine, liquid, toxic, nos	6.1	UN1851	6.1
Toxic, liquids, organic, nos	6.1	UN2810	6.1
Toxic solids, organic, nos	6.1	UN2811	6.1
Infectious substances, affecting humans	*6.2*	*UN2814*	*6.2*
Infectious substances, affecting animals only	*6.2*	*UN2900*	*6.2*
Radioactive material, low specific activity (LSA-I) non-fissile or fissile-excepted	7	UN2912	7
Oxidizing liquid, nos	5.1	UN3139	5.1
Hypochlorites, inorganic, nos	5.1	UN3212	5.1
Medicine, liquid, flammable, toxic, nos	3	UN3248	3, 6.1
Medicine, solid, toxic, nos	6.1	UN3249	6.1
Regulated medical waste, nos or clinical waste, unspecified, nos or (BIO) Medical waste, nos	*6.2*	*UN3291*	*6.2*
Biological substance, Category B	*6.2*	*UN3373*	

Note: nos, not otherwise specified

Table III. HMT portion that may be relevant to medical waste, including medical waste (written in italic)

Other than infectious waste, the UN classification of medical waste does not consider other categories of waste that may arise in health-care establishments (such as chemical or cytotoxic wastes) as medical waste. Hazardous medical waste of the chemical category can be found in the Hazardous Materials Table depending on the hazard class it belongs to. Table III is a summary for other classes that may be relevant to health-care waste.

Classification in different countries

As has been mentioned earlier, different countries have adopted their own medical waste classification. These classifications may be different or similar in part to the international bodies' classification. In addition, in many parts of the world, it is also not clear whether medical waste comprises only hazardous medical waste or both hazardous and non-hazardous medical wastes (Komilis *et al.*, 2012). For example, in Japan, infectious medical waste is defined upon the form of waste (blood, tissues, sharps, etc.), place of waste generation (operation theater, emergency room, intensive care units, etc.), and the kind of infectious disease (AIDS, tuberculosis, cholera, malaria, etc.) (Miyazaki and Une, 2005).

In Greece (Komilis *et al.*, 2012) and Bangladesh (Patwary *et al.*, 2011a, b), medical waste is divided into hazardous medical waste and non-hazardous medical waste (similar to household municipal solid waste and can be disposed off in a similar way). In Greece, hazardous medical waste is further divided into infectious waste, infectious and toxic waste (waste that has both infectious and toxic nature), and toxic waste (waste that has only toxic nature). Greek regulations also includes a fifth category "other" which includes radioactive materials, gases under pressure, and other materials (Graikos *et al.*, 2010). In Turkey, wastes produced by health-care facilities are divided into municipal solid wastes, hazardous wastes, radioactive wastes, and medical wastes (Birpinar *et al.*, 2009). The latter group is further classified into infectious wastes, pathological wastes, and sharp objects.

In Brazil, medical wastes categories have increased from four groups (Da Silva *et al.*, 2005) to five groups (Moreira and Günther, 2013). The new five groups are as follows: Group A represents wastes that present risk due to the presence of biological agents; Group B represents waste that present risk due to physical, chemical, and physical-chemical characteristics; Group C represents radioactive wastes; Group D represents general waste (paper, cardboard, plastic, metals, glass, organic substances, food leftover, and toilet paper); and Group E represents sharp devices (Moreira and Günther, 2013). Cameroon divides its medical waste into general wastes, sharps, infectious wastes, and chemical/pharmaceutical wastes (Manga *et al.*, 2011).

In China, medical waste is classified into five main groups (tissues, infectious waste, sharp objects, chemical waste, and medicine waste) (Yong *et al.*, 2009). Medical waste is classified into infectious waste and general medical waste in Taiwan (Cheng *et al.*, 2010, 2009).

Jordanian classification of medical waste

The Jordanian Bylaw number 1 for the year 2001 "Medical Waste Management Bylaw" classifies medical waste in a similar way to the WHO classification (MOH, 2001). However, the Jordanian law differentiates between infectious waste and highly infectious waste by providing different container colors to these two categories. In addition, genotoxic waste is also given a different color that distinguishes it from other chemical waste. Table IV gives the different colors that are recommended for different categories according to the different classification systems.

Generation rates

Due to the different definitions and different classifications of medical waste in different countries, a wide range of generation rates in kilograms per bed per day of

Container color	Type of waste collected in different color containers		
	WHO[a]	Basel	Jordan[c]
Black	General health care waste	Category A (non-risk waste), small quantities of category B1 (anatomical), class B31 (non-hazardous pharmaceutical waste)	General health care waste
Red	[b]	–	Highly infectious
Yellow	Highly infectious, infectious, pathological and anatomical, sharps	B1 (anatomical), B2 (sharps), B4 (cytotoxic), B5 (blood and body fluids), C1 (infectious), C2 (highly infectious), E (radioactive)	Infectious, pathological, sharps
Brown	Chemical and pharmaceutical waste	B32 (potentially hazardous pharmaceutical), B33 (hazardous pharmaceutical), D (other hazardous waste such as chemicals and heavy metals)	Chemical waste
Blue	–	–	Chemotherapy waste[d]

Table IV.
Container colors recommended for different categories of medical waste

Notes: [a]Lead box labeled with "Radioactive Waste" should be used for radioactive waste; [b]red containers are recommended for highly infectious waste to be autoclaved onsite before being transported, then are transferred to yellow containers for transportation; [c]radioactive medical waste is handled under a different law and under a different authority; [d]chemotherapy waste is the main source of genotoxic medical waste

medical waste appear in the literature. In addition, some of these studies based their generation rates on 100 percent occupancy rates (Bdour *et al.*, 2007; Birpinar *et al.*, 2009) while others based their figures taking into account the reported occupancy rates (Abdulla *et al.*, 2008). This can also be caused by the differences in the method used in getting the results. Results can be obtained by direct measurements at different sections inside the hospital (Komilis and Katsafaros, 2011) or by using questionnaires (Birpinar *et al.*, 2009) or as is the case in the present study by weighing the waste at the disposal site (in this case at the incinerator).

Table V summarizes the generation rates reported in different countries. Note that some of these figures reported in Table V are for medical waste others are for hazardous or infectious medical waste according to the classification of each of these countries.

A number of studies have been made in Jordan to evaluate medical waste management in Jordanian hospitals (Oweis *et al.*, 2005; Bdour *et al.*, 2007; Abdulla *et al.*, 2008; Fraiwan *et al.*, 2013). These studies evaluated medical waste management in different departments in the hospitals. It was found that the total waste generation rate ranges between 6.10 kg/patient/day (3.49 kg/bed/day) and 4.02 kg/patient/day (1.88 kg/bed/day) (Bdour *et al.*, 2007). Other studies found that the generation rates are lower and ranges from 0.26 to 2.6 kg/bed/day (average 0.83 kg/bed/day) (Abdulla *et al.*, 2008) and 0.73 kg/bed/day (Fraiwan *et al.*, 2013).

Country	Generation rate range (average) (kg/bed/day)	Type of medical waste	Reference
Jordan	1.88-3.49	Medical waste	Bdour *et al.* (2007)
Jordan	0.26-2.6 (0.83)	Medical waste	Abdulla *et al.* (2008)
Jordan	0.73	Medical waste	Fraiwan *et al.* (2013)
Turkey	0.63	Medical waste	Birpinar *et al.* (2009)
Turkey	2.11-3.83	Medical waste	Eker and Bilgili (2011)
Bangladesh	0.25	Hazardous medical waste	Patwary *et al.* (2009)
Bangladesh	1.2	Total medical waste	Rahman *et al.* (1999)
Tanzania	0.84-5.8	Medical waste	Mato and Kassenga (1997)
Mauritius	0.072-0.179	Hazardous medical waste	Mohee (2005)
Mauritius	0.398-0.478	Total medical waste	Mohee (2005)
Iran	4.42	Total waste	Dehghani *et al.* (2008)
Iran	0.4-1.91	Hazardous medical waste	Taghipour and Mosaferi (2009)
Egypt	0.23-2.07 (0.85)	Medical waste	Abd El-Salam (2010)
Bahrain	0.038	Hazardous medical waste	Mohamed *et al.* (2009)
Libya	0.9	Medical waste	Sawalem *et al.* (2009)
Greece	0.1 kg/patient/day	Hazardous medical solid waste	Graikos *et al.* (2010)
Greece	1.4	Infectious medical waste	Tsakona *et al.* (2007)
Greece	0.58 kg/occupied bed/day	Infectious medical waste	Sanida *et al.* (2010)
Greece	0.24-0.33 kg/bed/day 1.20 kg/occupied bed/day	Hazardous medical waste	Komilis *et al.* (2011)
China	0.77-1.22	Medical waste	Ruoyan *et al.* (2010)
China	0.5-0.8 (0.68)	Medical waste	Yong *et al.* (2009)
South Korea	0.14-0.49	Hazardous medical waste	Jang *et al.* (2006)
Japan	0.471	Hazardous medical waste	Tanaka *et al.* (2003)
Japan	1.5-3.0	Total medical care waste	Tanaka *et al.* (2003)
Brazil	3.245	Total medical waste	Da silva *et al.* (2005)
Brazil	0.57	Infectious-biological waste	Da silva *et al.* (2005)

Table V.
Generation rates of medical waste in different countries

Medical waste tracking

Many countries (Jang *et al.*, 2006; Huang and Lin, 2008) have adopted a paper work tracking or manifest system to document the generation of waste, all the subsequent processes that it may go through, offsite transportation, and disposal.

In South Korea for example, the manifest used to track hazardous waste is also used to track medical waste. The manifest form consists of four or six copies (depending on the size of the hospital) that contain information about waste generator, waste transporter, treatment facility, and the type of waste being transported. An online manifest system has also been used to track medical waste in real time. All parties involved can track the waste, reducing time, energy, and cost (Jang *et al.*, 2006). The paperwork accompanies the waste shipment and provides a record of waste movement from the waste producer (medical facilities) through each intermediate management stage to final treatment and disposal. In Korea, the government regulatory agency receives two copies of the manifest from the disposal or treatment facility at the end of the tracking process. Medical waste generators receive a copy of the manifest form the disposal or treatment facility, thus completing the cradle to grave tracking concept.

In Taiwan (Huang and Lin, 2008), generators of medical waste must either complete a six-copy paper work manifest or a three-copy online manifest form. In the six-copy manifest, the governmental agency responsible receives a copy of the manifest at the beginning of the shipment from waste generators and at the end of the shipment from the disposal or treatment facility. The medical waste generator keeps a copy and receives another copy from the disposal or treatment facility within 30 days of delivery and within seven days of the completion of waste disposal. The transporter and the treatment or disposal facility each keeps a copy of the manifest. The law in Taiwan specifies dates for different parties involved for the delivery of manifest and delivery of waste. As a result of problems associated with the implementation of the six-copy manifest which included unnecessary time consumption, data absence, and misjudgment by the operators, an online three-copy manifest system was introduced. In this system, the medical waste generator fills the manifest online and print three copies. One copy is retained by the waste generator and the other two are retained by the transporter and the disposal or treatment facility.

In order for a manifest system to work efficiently, waste has to be first stored upon generation. The waste generator needs to have a system to safely store waste until it can be transferred for further storage, treatment, or disposal. Waste is then collected and transported offsite to a waste treatment and/or disposal facility. Upon transporting, waste has to be clearly identified and labeled with the type of waste. The packaging should be secure enough to prevent leaks, spills, and vaporization during transportation. Transportation of waste should be subject to a permit issued by the regulatory authority to contractors with approved vehicles and trained drivers. Each vehicle carrying waste should be identified using appropriate symbols or labels. Each movement of waste should require a transport certificate showing the origin and destination. The carrier must ensure that he has the necessary information on the waste to be transported, and formulated an emergency plan in the event of spillage. Once the waste reaches the treatment and/or disposal facility, the cycle of the "cradle to grave" concept ends. All these steps have to be recorded and be easily tracked, in order to prevent any illegal dumping of waste, and to hold any party accountable of their acts.

The objective of this paper was to introduce a manifest system for the tracking of medical waste in Jordan. As part of this effort, medical waste classifications in different

parts of the world were conducted to help adopt a classification appropriate for use with the manifest system, either at the present time or in the future. The types and quantities of medical waste in Jordan are key parameters for appropriate management of these types of wastes, of which the manifest system is one important management tool. Therefore, medical waste generation types and rates in selected number of hospitals in the northern part of Jordan were evaluated as part of this effort.

2. Methods

As a result of the different medical waste generation rates in Jordan, one objective of this work was to calculate average medical waste generation rate. Generation rates from 11 public hospitals and one governmental university hospital from the northern part of Jordan were evaluated. The hospitals chosen in this study were all hospitals that send their medical waste to the same incinerator. They do so because these hospitals have no incinerators onsite and because the distance to the incinerator makes it the least costly alternative. The hospitals studied represent the majority of public hospitals, including the largest three hospitals in the northern part of Jordan. Only public hospitals were chosen to be studied, because private hospitals that send their medical waste to this incinerator are few and not representative of private hospitals.

Site visits to the incinerator were conducted for data collection. The amount of each category of medical waste declared and hauled to the incinerator by each hospital was obtained monthly. Interviews with personnel in charge of medical waste incineration were conducted. As a result, the 12 hospitals were chosen to be studied. The study was based on weighing all medical wastes that were disposed off by these hospitals for a period of 12 months during the year 2012. No attempt was made to characterize medical waste inside the hospitals. Only disposed off waste after it has left the hospital for incineration was observed and characterized, and weighed. As the hospitals were not studied or surveyed from inside, there is no information about how the waste was separated or classified inside the hospitals. However, all these hospitals are supposed to follow the Jordanian classification of medical waste shown above in Table IV.

All the medical waste shipments were accompanied by a paper work that is mainly intended for billing purposes. The paper work was not intended to track medical waste from cradle to grave. In addition, it is not required by law to send this paper work to any governmental agency, nor it is required to keep a copy of this paper work by all the parties concerned.

In calculating the generation rate, one can choose between the number of total beds in the hospital or, the number of occupied beds. No attempt was made to calculate the occupancy rates in these hospitals. Bed occupancy is not readily available figure and can change with time (Komilis *et al.*, 2012). Bed occupancy, which is a parameter that can change from day to day in a hospital, was not available for the hospitals in this study. The official number of beds was used as a basis for calculating generation rates in a number of studies (Birpinar *et al.*, 2009; Cheng *et al.*, 2009; Komilis *et al.*, 2011). Occupancy rates in public hospitals in Jordan are usually very high, and the assumption of 100 percent occupancy rate is thus justified.

In addition, a review of the different methods used to classify medical waste was conducted. The proposed medical manifest adopted the WHO classification as it is somewhat similar to the current Jordanian Bylaw managing medical waste (MOH, 2001), although a different classification would probably be more appropriate for Jordan, as will be shown later in this paper.

3. Results

Medical waste generation rate in Jordan

Table VI shows the generation rates of the 12 hospitals studied. The rates range from 0.88 to 3.05 kg/bed/day. These rates are for the categories shown in Figure 1, namely, infectious, sharps, pathological, and pharmaceutical waste. As mentioned earlier, these values are based on the medical waste that has been disposed off by these hospitals.

Figure 1 shows the percentages of different medical waste categories for all the 12 hospitals in the study combined. The figure shows that about 82 percent of the waste is infectious and 15 percent are sharps. These values are close to the 90 percent infectious waste and 10 percent sharps, reported by Abdulla *et al.* (2008). Pathological wastes were about 2 percent and pharmaceutical wastes were <1 percent.

Figure 2 also shows that the medical waste generations by these hospitals were different for different months of the year. Waste generation was higher during the summer months than during the winter months. The largest generation was during August while the minimum occurred during January.

Hospital	Beds	Type	kg/bed/day
A	304	General	1.35
B	61	General	1.55
C	109	Gyn-Obsterics	1.10
D	95	Gyn-Obsterics	1.10
E	202	General	2.04
F	60	General	2.27
G	60	General	2.50
H	46	General	3.05
I	32	General	2.49
J	105	General	0.88
K	135	General	2.22
L	108	Gyn-Obsterics	1.51
Summation	1,317	Average	1.67

Table VI.
Average generation rates for the different hospitals studied

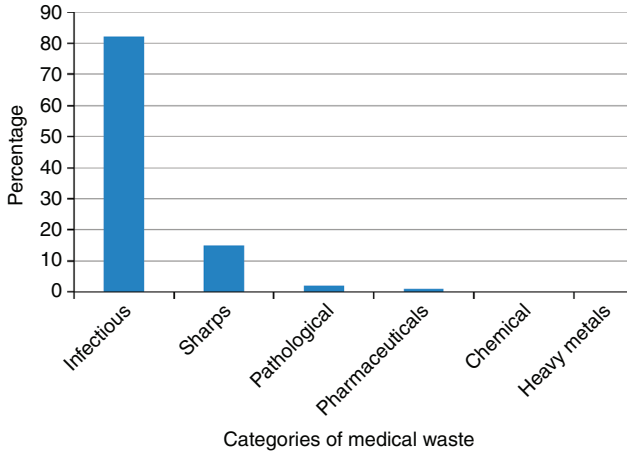


Figure 1.
Percentages of different medical waste categories for all hospitals in the study

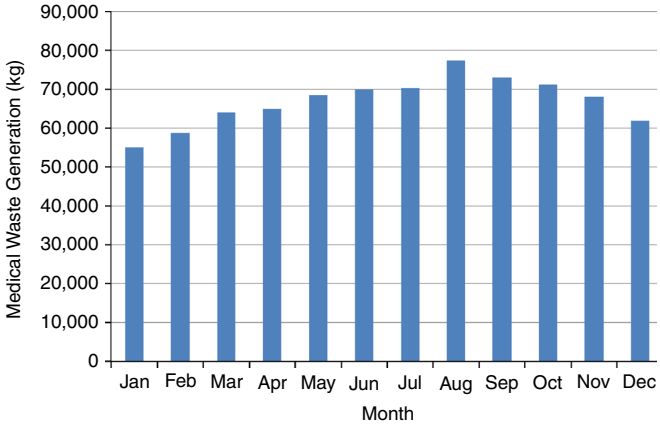


Figure 2.
Monthly generation of medical waste (kg) for all hospitals in the study

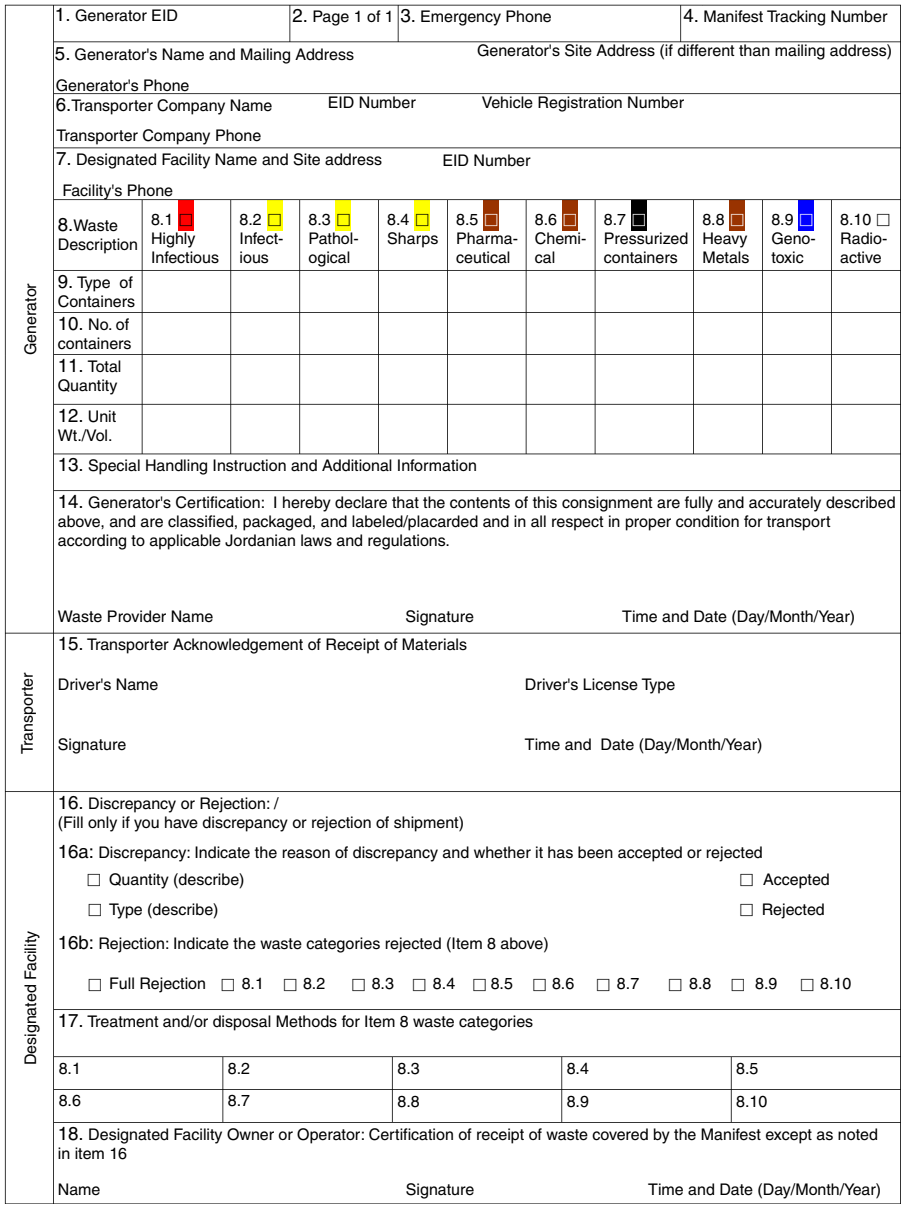
Jordan medical waste manifest

The need for a medical waste management system begins directly from the generation of such waste and continues through all subsequent stages to the final treatment and disposal. Such system is really a series of management actions to control and contain the waste coordination among various persons and groups of persons. Such management system requires generators to bear responsibility of dealing with waste in a responsible way. The basic tenet of this system is a "Cradle to Grave" tracking system, meaning that the waste generators must track waste from the moment such waste is produced onsite to the eventual treatment or final disposal site of that waste.

Medical Waste Manifest Form. The Medical Waste Manifest Form (Figure 3) presented in this section is mainly adopted from the Industrial Waste Manifest Form, recommended for use in Jordan, with a few changes and, of course, with different waste classification. The manifest consists of three sections. The first section is filled by the generator (hospitals in this case). It consists of information about the generator, the transporter, and the designated facility. This section also contains the waste description, along with any special information about the waste. This section ends with the time, date, generator name, and signature.

The second section of the manifest (Figure 3) is filled by the transporter. In this section the transporter acknowledges the receipt of the waste described by the generator in the manifest by writing his name and signing and dating this section of the manifest. The time of shipment is also indicated.

In the third section, the owner or operator of the treatment and/or disposal facility acknowledges the receipt of the waste by writing his name, and signing and dating this section of the manifest (Figure 3). The time the designated facility receives the waste is also indicated. The owner or operator states the name of the method used in the management or treatment of the waste, and lists any discrepancies between the shipped waste and the waste described by the generator in the manifest. Manifest discrepancies are significant differences between the quantity or type of medical waste designated on the manifest, and the quantity and type of medical waste a facility actually receives. The owner or operator should indicate whether the waste in which there is discrepancy has been accepted or rejected. The type of treatment and/or disposal methods used to manage the accepted waste should be indicated in the manifest. The ten boxes available with numbers 8.1-8.10 in the manifest are for the



Generator

1. Generator EID	2. Page 1 of 1	3. Emergency Phone	4. Manifest Tracking Number

5. Generator's Name and Mailing Address — Generator's Site Address (if different than mailing address)

Generator's Phone

6. Transporter Company Name — EID Number — Vehicle Registration Number

Transporter Company Phone

7. Designated Facility Name and Site address — EID Number

Facility's Phone

8. Waste Description	8.1 Highly Infectious	8.2 Infect-ious	8.3 Pathol-ogical	8.4 Sharps	8.5 Pharma-ceutical	8.6 Chemi-cal	8.7 Pressurized containers	8.8 Heavy Metals	8.9 Geno-toxic	8.10 Radio-active
9. Type of Containers										
10. No. of containers										
11. Total Quantity										
12. Unit Wt./Vol.										

13. Special Handling Instruction and Additional Information

14. Generator's Certification: I hereby declare that the contents of this consignment are fully and accurately described above, and are classified, packaged, and labeled/placarded and in all respect in proper condition for transport according to applicable Jordanian laws and regulations.

Waste Provider Name — Signature — Time and Date (Day/Month/Year)

Transporter

15. Transporter Acknowledgement of Receipt of Materials

Driver's Name — Driver's License Type

Signature — Time and Date (Day/Month/Year)

Designated Facility

16. Discrepancy or Rejection: /
(Fill only if you have discrepancy or rejection of shipment)

16a: Discrepancy: Indicate the reason of discrepancy and whether it has been accepted or rejected

☐ Quantity (describe) ☐ Accepted

☐ Type (describe) ☐ Rejected

16b: Rejection: Indicate the waste categories rejected (Item 8 above)

☐ Full Rejection ☐ 8.1 ☐ 8.2 ☐ 8.3 ☐ 8.4 ☐ 8.5 ☐ 8.6 ☐ 8.7 ☐ 8.8 ☐ 8.9 ☐ 8.10

17. Treatment and/or disposal Methods for Item 8 waste categories

8.1	8.2	8.3	8.4	8.5
8.6	8.7	8.8	8.9	8.10

18. Designated Facility Owner or Operator: Certification of receipt of waste covered by the Manifest except as noted in item 16

Name — Signature — Time and Date (Day/Month/Year)

Figure 3.
Proposed medical waste manifest

accepted medical waste descriptions in item 8 of the manifest, respectively. The time the facility received the waste should also be indicated.

According to Manifest Chain of Custody, the original colored copies of the Medical Waste Manifest Form will be distributed as follows:

- Page 1 (top copy): "Generator copy to ministry of health (MOH)"
- Page 2: "Generator copy for recordkeeping"

- Page 3: "Designated (Receiving) facility copy to MOH"
- Page 4: "Designated (Receiving) facility copy for recordkeeping"
- Page 5: "Designated (Receiving) facility copy to transporter"
- Page 6: "Designated (Receiving) facility copy for generator"

Every medical waste generator, transporter, and designated facility must submit an annual report summarizing all he waste shipment that the facility has been involved in transporting or receiving. In addition, every medical waste generator, transporter, and designated facility must apply for registration and licensing at the Ministry of Environment to obtain a permit as well as an Environmental ID Number. Such number will be used to identify such facility in all manifest system documentation.

4. Discussion

The introduction of a medical waste manifest is an important step toward integrated waste management in Jordan. An essential element in the successful implementation of the manifest system is a medical waste classification that can be implemented easily throughout the tracking process. As a result, a comprehensive review of the different medical waste classification systems around the world was conducted. The different classifications of medical waste in the world make it necessary for developing countries like Jordan to adopt one of these classifications and tailor it according to its local conditions without jeopardizing public health.

Although Jordan follows the WHO classification of medical waste, a classification system that is tailored to the conditions of Jordan should be followed. As Figure 1 shows, the ten categories of medical waste present in the proposed manifest shown above, are not present or are difficult to follow in these hospitals. This is true as the large number of waste classification complicates the issue of segregation and management. In the future, it is recommended that Jordan follows a different classification of medical waste that is different from the WHO classification. A classification that is a mix between the Japanese classification, Brazilian classification, and Greek classification discussed above could be adopted. Another classification could be based on the type of treatment (waste that should be incinerated, waste that should be landfilled). As is the case in Japan, a classification based on the place of waste generation (waste from operation theaters, waste from intensive care units, waste from emergency rooms, etc.) could also be adopted in Jordan. This makes it easier to classify and manage medical waste inside the hospitals and when using manifests to haul, treat, and dispose off medical waste.

Another important step toward integrated medical waste management is to estimate the amount of medical waste being generated and that could be generated in the future. This is also important for planning of medical waste haulers and treatment or disposal facilities which are essential parts of the medical waste manifest system. Therefore, medical waste generation rate in 11 public hospitals and one governmental university hospital were evaluated. The results and values obtained are representative of medical waste generation rates in public hospitals. Public hospitals in Jordan have no incentive to illegally dispose off their medical waste, nor do they have incentives to perform waste reduction measures at their hospitals.

As Figure 2 above shows, medical waste generation rates during summer were found higher than during winter. Although it is difficult to speculate about a reason for such difference, this may be due to higher occupancy rates during summer. Despite the fact that occupancy rates in public hospitals are usually very high throughout the year,

Jordanians working abroad, especially in the Gulf States, return back to Jordan during summer and perform the needed medical operations. This is mainly due to lower medical treatment cost in Jordan compared to other countries. This may be the reason for the increase in medical waste generation rate in summer.

5. Conclusion

A program that introduces a medical waste manifest in Jordan is described. As part of the program, different classifications of medical waste according to international bodies and in different countries are described. The presently recommended manifest adopted the WHO classification with minor changes, although other classifications could be used in the future to suit Jordanian conditions. This manifest tracks medical waste from cradle to grave, and makes illegal dumping very difficult. In addition, medical waste generation rates and medical waste classification were evaluated for 12 governmental hospitals in the northern part of Jordan. The results have shown that the annual average generation rate ranges from 0.88 to 3.05 kg/bed/day based on 100 percent occupancy rate, of which 82 percent were infectious waste and 15 percent were sharp objects. The generation rate increases in the summer months as compared to winter months.

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