Recycling and Sustainable Development

www.rsd.tfbor.bg.ac.rs

Online ISSN 2560-3132
Print ISSN 1820-7480

Hospital Hazardous Waste Management: Treatment, Storage and Disposal

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ARTICLE INFO

Received 03 August 2021
Accepted 03 March 2022

Research article

Keywords:
Hospital
Waste
Erbil
Management
Environment

ABSTRACT

Rapid population growth, industrialization, and growth of demand for raw materials for industrial and medical production result in generating a huge amount of hazardous waste. Hazardous waste is identified by its toxicity, flammability, and radioactivity characteristics. Disposing hazardous waste into the natural environment has a significant impact on health and all living things in the environment. Nowadays, numerous hospitals and industrial places generate a large amount of hazardous waste. The objective of this study is to evaluate the management system of hazardous hospital waste in Erbil city. Additionally, the focus is on hazardous hospital waste management and characterizations and situation of the waste in Erbil city as well. The generation rate of hazardous wastes from hospitals in Erbil city was collected for 12 months from 2015 to 2020. The results showed that the highest amount of medical hazardous waste was generated in 2019. Moreover, the number of onsite incineration centres should be increased to reduce the cost of storage and transportation.

1. Introduction

In recent decades, researchers have defined and classified hazardous waste as waste with chemical and physical characteristics, such as toxicity, ignitability, corrosivity, or other properties. The hazardous waste consists of household, medical, and industrial wastes. In addition, the management of hazardous wastes, including the way of disposing into the environment, is very crucial to achieve a lesser impact on human health and the natural ecosystem (Misra and Pandey, 2005). Increasing demand and consumption throughout the world and using chemicals in industries result in producing hazardous substances. 16,000 tons of hazardous waste are produced by 41 industries in Lebanon (El-Fadel et al., 2001). In China, hazardous waste was reported to have had the highest generation of 11.62 million tons in 2005 (Duan et al., 2008). Household solid wastes originate from home and may contain hazardous substances. It has been defined that such products are paints, cleaners, car batteries, e-waste, varnishes, motor oil, and pesticides (EPA, 2013). It is appraised that by 2030, developing countries will have discarded 400-700 million outdated computers. Many hazardous wastes, such as chemical photography wastes, oil wastes, battery wastes, mercury lamp wastes, electronic wastes, and heavy metal wastes with a printed circuit board (PCB), result from a large amount of trash. In some industrialised nations, household hazardous waste (HHW) may also come from municipal solid garbage. The most common recycling and recovering sectors are informal recyclers. The common safe methods in developing countries to manage hazardous waste are landfilling and incineration, however, other treatments (sterilization and microwave) have not been used. Thus, the accelerators of hazardous waste (HHW) cannot be avoided. Currently, the industry

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doi: 10.5937/ror2101043A

is sharing with the developed society waste products which are the main result of the activity of industrial countries. Increased uses of chemicals in industry produces hazardous material. Normally, the consumption trend increases the quantity of hazardous waste in the country. The way to increase material waste is to throw away the material without anticipating whether it could be hazardous waste in the environment. One way to characterize the waste as industrial is to assess its potential to become hazardous. The procedures that can generate this type of waste are tanning, electroplating, and use of pesticides, petroleum, and battery acids. This study illustrates the management of hospitals hazardous waste in Erbil city. In addition, the generation rate and characteristics of hospital hazardous waste, the method of treatment and storage of the waste were investigated as well.

2. Characteristics of hospital hazardous waste

According to the Environmental protection Agency (EPA), hazardous waste can be characterized as flammable, corrosive, toxic, reactive, and radioactive. Hazardous waste has the ignitability with high heat or any sources of fire as it has a flashpoint of less than 60 ºC such as alcohol, petroleum wastes, solvents, etc. (Bouis et al., 1999). The corrosively of hazardous waste causes damage and disease as it makes erosion and burns the skin. These wastes have a pH value less than 2.5 and more than 12.5 such as acidic wastewater, battery, etc. Cyanide, sulfide wastes, and TNT operations are examples of reactivity of hazardous waste. It is capable of exploding when mixed with water which produces toxic compounds. Moreover, toxic compounds such as heavy metals; arsenic, barium, benzene, chrome, etc, exhibit the toxicity characteristics of hazardous waste. In addition, another characteristic of hazardous waste is having radioactive elements. These wastes significantly originate from biomedical training and research institutes. Wastes may include radioactive elements of iodine, cobalt, and uranium (Tadesse, 2004).

2.1. Medical waste

Health and related services such as hospitals, health centres, clinics, and research institutes are sources of medical waste (Sartaj et al., 2015). It consists of of heavy metals, radioactive, genotoxic, pathological waste, chemical toxins, human blood, blood parts, waste of infection, and sharps which include syringes, knives, broken glasses, scalpels, and needles. Currently, there is no statistical information data about the medical waste in developing countries. Olukunle et al. (2015) mentioned that in some conditions medical waste quantity was estimated based on accounting for the number of beds in the hospital. The example is Dhaka, Bangladesh where about 37 tonnes of the medical products waste was recorded (Patwary et al., 2009). On the other hand, Manga, et al. (2011) argued that the medical waste had low ratio in some developing countries. Municipal solid waste (MSW) is recorded to have high ratio of medical wastes and there is no control and monitoring of the wastes. The main way to control medical waste is incineration treatment. Therefore, there ara lacks in operation treatment of medical waste in some developing countries. The consequence of pollution results from simple technology and primitive equipment.

3. Treatment and disposal of hazardous waste

Hazardous waste management is comprised of the transportation, disposal of waste, storage, handling, and possessions. Hazardous treatment happens in uncontrolled situations and irregular conditions in developing countries, and hazardous waste is exported to some developing countries by the developed countries (Thanh et al., 2010). It was recorded that the treatment of hazardous was done by the unlicensed conventional method, for example, Landfill. According to Patwary et al. (2011), the treatment of hazardous waste by authority was done with low standards or regard to the environment and technology. The examples are landfills, oil recovery, and incineration plants. The most important hazardous waste is mixed with non-hazardous material. This has influence on the environment and human lives and it creates high-risk health problem to the public and environment. This indicates that hazardous waste in developing countries needs to use a new strategy and new technology to improve the environment from hazardous materials. Modern technology, high recycling techniques and managing hazardous waste that highly affects the environment, economy, technically feasible and social standards. Hazardous waste is present in South Africa which is one of the developing countries (Olukunle et al., 2015). There are challenges in some developing countries to develop hazardous waste disposal due to regularity, financial resource, social acceptance, limited technology, and infrastructure and manpower skill. It indicates that landfill is not crucial in their society. It shows that the combustible hazard needs to be monitored and new infrastructure for the wastes do not exist. The common environmental issue such as Contamination of soil and animal threats may be a result of oils and indiscriminate or e-wastes. Healthcare facilities are mixed with water channels that are not properly cleaned. Monitoring of the environmental risks is related to the practices which have not been done due to poor technique and man skill. Industrial hazardous waste can be defined as waste that comes from sectors of the industrial and it through to the environment (Naviaa et al., 2008). Industrial hazardous waste is recognized by high toxic (chronic, extrinsic and acute), reactivity, corrosiveness and flammability. Industrial hazardous waste sources are chemical, mechanical, paper, pulp, mining, wood and cement

production and important Industrial hazardous waste is contaminated oil (Thanh et al., 2010). In some countries using industrial wastevis high, for example, in Lebanon is around 3,000 - 15,000 ton/Y this is due to the lack of an environmental plan. Furthermore, there are little data collected about Industrial hazardous waste to know where and where generated and goes. Due to the fluctuation the mass manufacturing, economic, industrial process, environmental quality leads to an increase the Industrial hazardous waste. A large portion of hazardous waste is missed with non-hazardous from landfills that through to the water and make more environmental problems (Olukunle et al., 2015). Researchers have found that in origin the waste is not discrete from hazardous and non-hazardous substances. Also, non-hazardous substances are not discrete from recyclable and non-recyclable. Researchers have found that some developing countries do not have regulation which leads to hazardous waste. In addition, the separation for the rest of the wastes is easily in developing countries. This indicates that possible and urgent policies need to stimulate industry, manage society and reduce the hazardous problem.

4. Current situation of hospital hazardous waste in Erbil City

4.1 Study area and data collection

Erbil city is the capital of the Kurdistan region located at 35º 27' N to 37º 24' N Latitude and 43º 15' E to 45º 14' E longitude. The population of the city area is around 1,300,000 citizens (Khudhur and Khudhur, 2015). The solid waste generation in Erbil city varies between 0.8 to 1.4 kg per capita per day. The amount and composition of solid waste in households in Erbil city varies depending on lifestyle and members of the family. The collected solid waste from Erbil city is dumped and buried in the Kani-Qrzhala dumpsite which is far from the city centre about 15 km from the northwest (Aziz et al., 2011). Erbil landfill site at Kani-Qrzhala is opened in 2001 and it is not constructed and designed as a sanitary landfill. Since there are no facilities in the city to recycle the inorganic materials and separate components of the generated solid waste, therefore; the landfill receives all types of solid waste around 2,000 tones daily including municipal, commercial, household hazardous, industrial and final products from the incineration of medical wastes from hospitals. This study focuses on the management of hospital hazardous waste and in addition, the current study investigates the current situation, generation and treatment of hazardous waste in Erbil city. The data is collected from the Erbil Environment office (EEO). The data contains monthly generation of medical hazardous waste from various hospitals from 2015 to 2020. The wastes data include infectious waste, sharp waste, pathological waste, etc. The data was then organized using Microsoft office excel and the total annual waste generated was calculated for the year 2015 till 2020 (Appendix 1).

Hazardous waste in Erbil city significantly comes from medical waste which is followed by hospitals and industrial locations. Currently, numerous amount of hospitals are serving inside the city. These hospitals use chemicals in laboratories to treat their patients, so by the end, it will generate a huge amount of hazardous wastes which may contain heavy metals and toxic compounds. Figure 1 shows the location of hospitals in Erbil city.

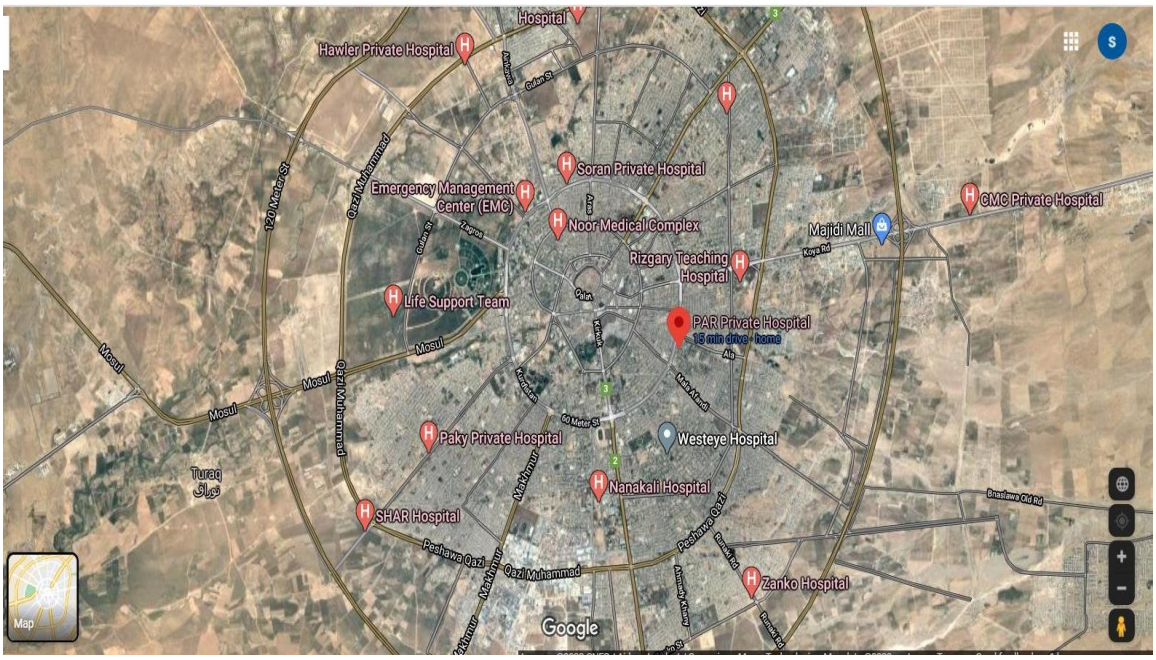


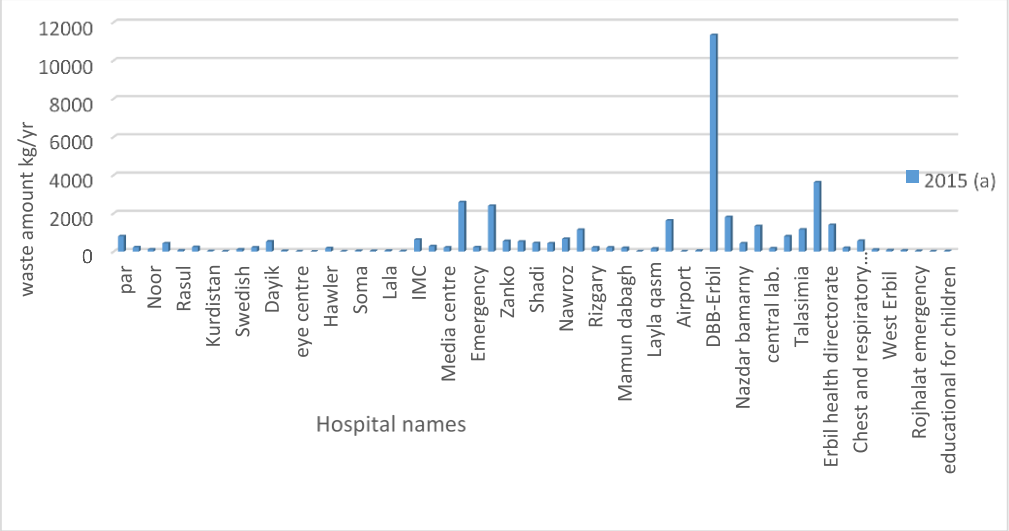
Figure 1. Location of hospitals in Erbil city

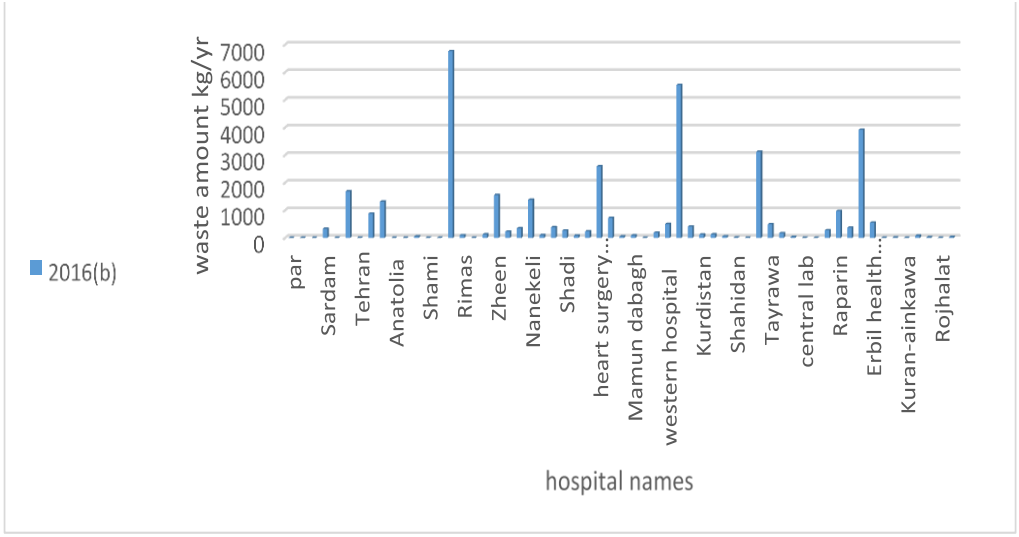
From data, the generation rate of medical wastes at hospitals for 12 months during the years 2015 till 2020 (Appendix 1). The production of medical wastes is sent to two main treatment unit plants; incineration device which is constructed at Nanekali and childbirth hospitals in Erbil city. The wastes are autoclaved and then incinerated under high temperature then the ash is collected and disposed to the Erbil landfill site near KaniQrzhala district. However, sometimes some hospitals dump their medical waste directly into landfill sites and mix it with municipal solid wastes without separation and aggregation (Figure 2).

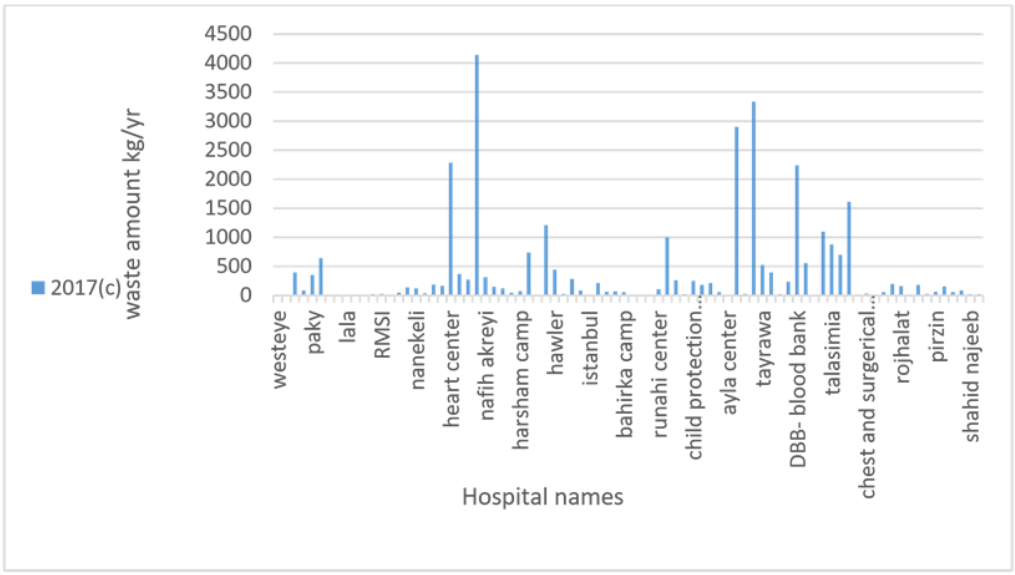
Figure 2. Mixed solid waste and medical waste at Erbil landfill site

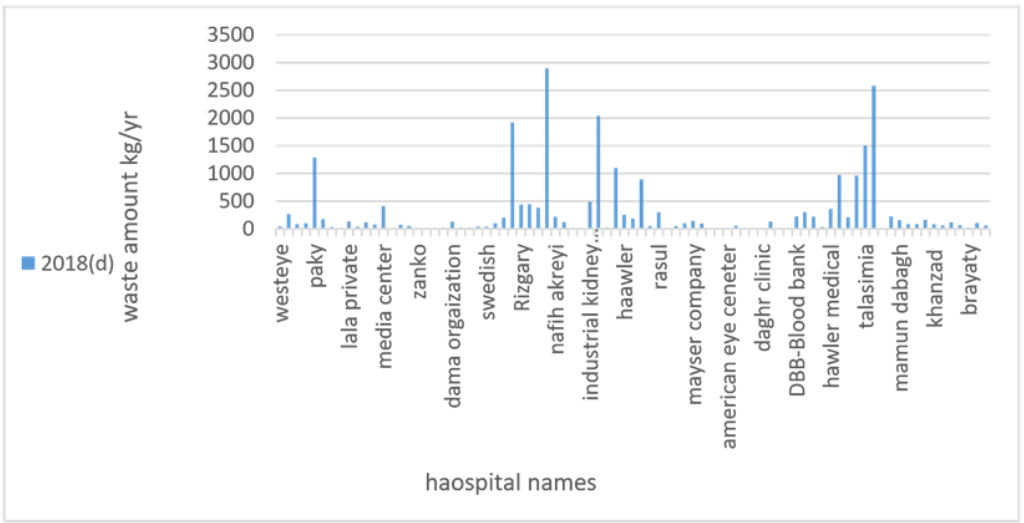
5. Results and Discussion

From Figure 4 shows the charts with hospital names and the amount of medical waste generated in kg/year. There are fluctuations in the amount of waste from the year 2015 to 2020. Some hospitals generate less amount of waste while some others generate more waste. In 2015 Directorate blood bank (DBB) recorded the highest value, about 12,000 kg per year of generated medical waste. While in 2016 Lala hospital recorded around 7,000 kg per year. In 2017 and 2018 blood centre hospitals generated the highest amount of medical waste around 4,000 and 3,000 kg per year respectively. In addition, Figure 4 shows that in the year 2019, the highest amount of waste was recorded from the blood centre hospital. Moreover, in 2020 the highest amount of waste was generated from industrial kidney centres which was 6,000 kg per year. The transportation of wastes from all hospitals was performed by a special truck which went to two main hospitals and collected waste to be autoclaved and incinerated by special devices then the final ash was disposed to Erbil landfill site. In 2020, the lowest amount of waste was generated, which meant that the lowest number of patients visited the hospital as mentioned by (Naemi et al., 2021). The most common process for controlling the process is called incineration, which converts solid oxidative material of combustible to material suitable for the atmosphere, for example gasses. It is changing the waste material to low harmful, noxious and bulky materials. According to Misra and Pandy, (2005 the incineration process was able to minimize the sludge material to ash remains, which could easily be used for disposal, and soluble poisonous metal oxides. (Bucătaru et al., 2021) explained that medical waste management flow should be followed by some steps starting from disposing of wastes to waste containers then storing in the designated installations after that vehicles should transport the wastes to the incineration treatment facility. The landfills which closed to burial the toxic material for example contaminated soil with hazardous material, polychlorinated biphenyls closed the landfill where the material wastes are restricted from the surrounding environment by wall, roof and floor. The rainwater has not been able to go through landfills which closed then, the amount of leachate will be very low (Lidskog, 1998).




2016(b)
waste amount kg/yr
7000
6000
5000
4000
3000
2000
1000
0
par
Sardam
Tehran
Anatolia
Shami
Rimas
Zheen
Nanekeli
Shadi
heart surgery...
Mamun dabagh
western hospital
Kurdistan
Shahidan
Tayrawa
central lab
Raparin
Erbil health...
Kuran-ainkawa
Rojhalat
hospital names


2017(c)
waste amount kg/yr
4500
4000
3500
3000
2500
2000
1500
1000
500
0
westeye
paky
lala
RMSI
nanekeli
heart center
nafih akreyi
harsham camp
hawler
istanbul
bahirka camp
runahi center
child protection...
ayla center
tayrawa
DBB- blood bank
talasimia
chest and surgerical...
rojhalat
pirzin
shahid najeeb
Hospital names


2018(d)
waste amount kg/yr
3500
3000
2500
2000
1500
1000
500
0
westeye
paky
lala private
media center
zanko
dama orgaization
swedish
Rizgary
nafih akreyi
industrial kidney...
haawler
rasul
mayser company
american eye ceneter
daghr clinic
DBB-Blood bank
hawler medical
talasimia
mamun dabagh
khanzad
brayaty
haospital names

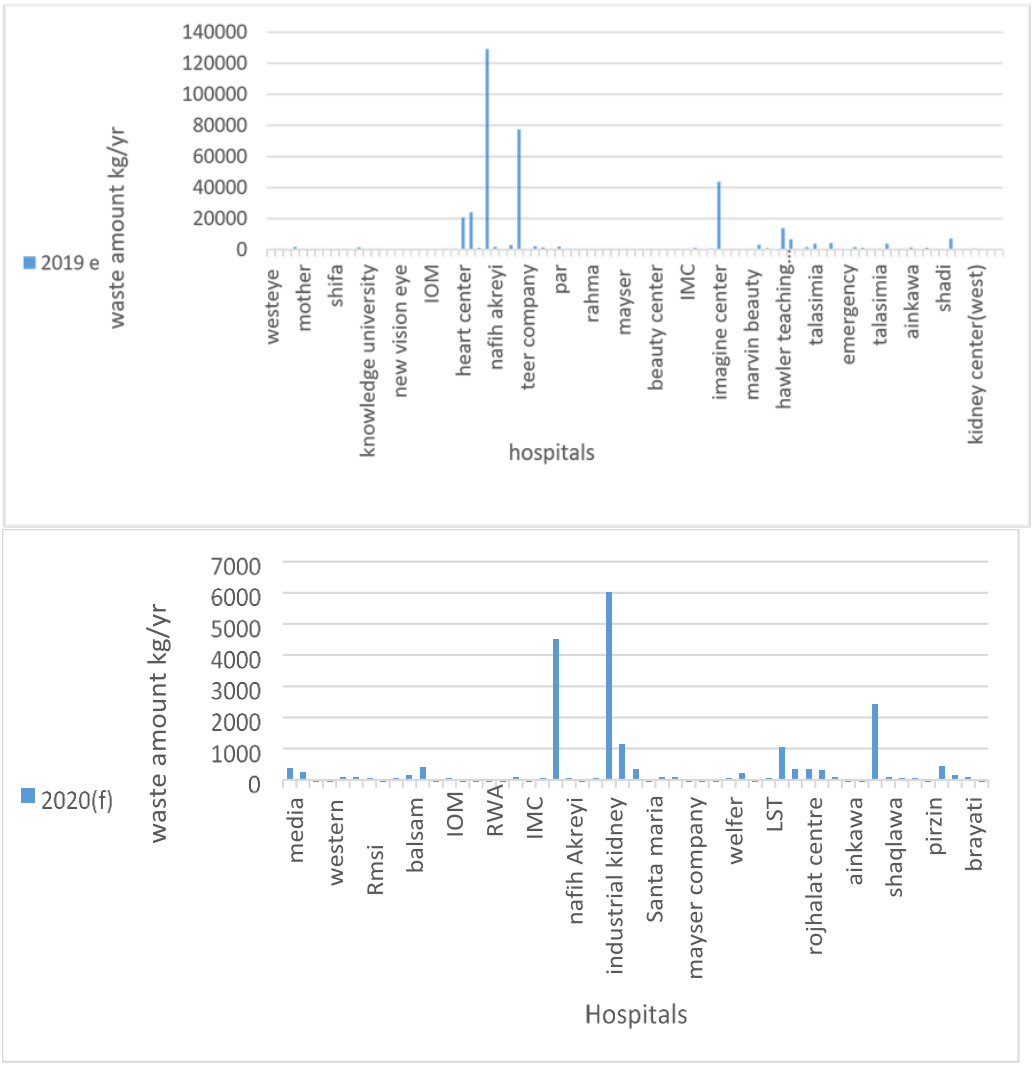


Figure 3. (a-f) The amount of medical waste generates in hospitals in Erbil city from 2015-2020 in kg/year

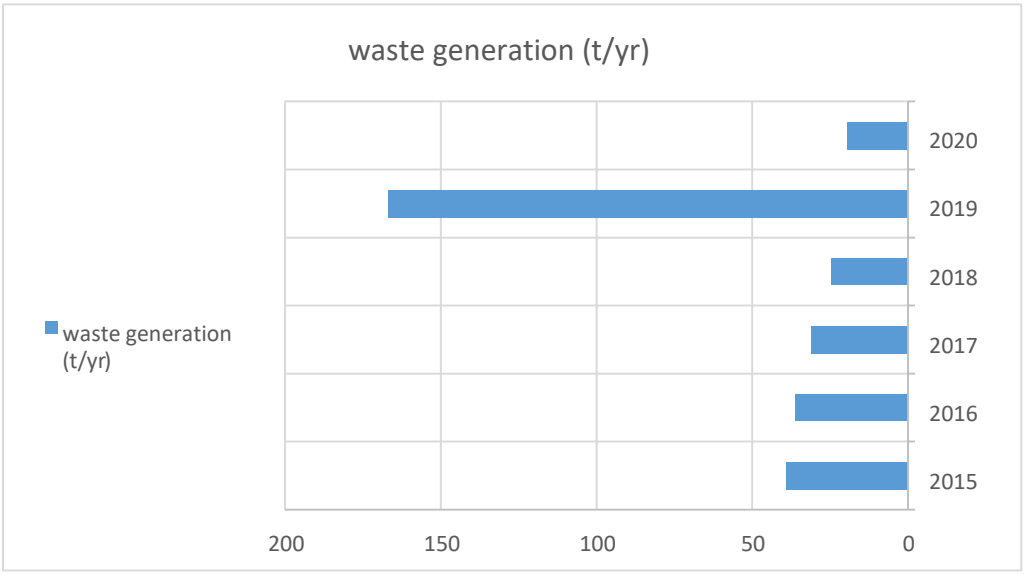


Figure 4. Yearly generation rate of hospital hazardous waste

Conclusion

This study discusses hazardous waste management with emphasis on industrial hazardous waste, medical waste, and household hazardous waste. It also identifies the current situation of hazardous waste management in Erbil city.

1. In Erbil city, due to rapid economic growth and industrialization, more than 25 hospitals have been opened and worked during the last few years. This generates a huge amount of hazardous waste with inadequate treatments.
2. Mercury compounds or polychlorinated biphenyls soils is called toxic material wastes that are buried into the landfill where there is isolated with the waste in the outer layer by wall, roof and concrete that help to protect from rain and the leached amount is very low.
3. There is a lack of a data on the quantities of the waste in the developing countries, which show the lack of awareness and capacity of hazardous waste disposal, lack of the product of hazardous waste, low penalties or incentive, stakeholder's responsibility, no clear role and infrastructure.
4. There are some challenges, such asfinancial sources, manpower skill, equipment, progressing framework, managing and monitoring of hazardous waste and testing facilities.
5. The main difficulty to the local authority to determine the objective of the long term of the hazardous waste are treatment system, disposal system, lack of the government responsibility and lack of data.
6. There is an important point that should be considered in order to succeed in hazardous waste management, and it is learning from the experience from some developed countries to combine with the context of the economic and social standard of the other developed country.
7. Reducing waste from reuse, recycling and source have influenced the minimisation of the hazardous material waste production and disposal. Also, it needs reform from the system of managing hazardous waste.

Acknowledgement

Author would like to thank the Erbil Environment office for providing the data to conduct this research. The author would like to express appreciation to Mr Dashty M.Ali who helped me to obtain the data for this study.

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Appendix 1

Medical hazardous waste generation from hospitals year 2015

No.	Hospital name	Jan	Feb	Mar	Ap	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (2015)
		Kg	Kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg/yr
1	par	94	160	83	35		91	72	41	117	107	-	-	800
2	west eye	24	16	23	54		37	28	43	-	-	-	-	225
3	Noor	6	5	12	-		39	-	5	42	8	-	-	117
4	Sardam	78	-	30	27		135	-	-	80	-	85	-	435
5	Rasul	30	30	-	-		-	-	-	-	-	-	-	60
6	Sima	34	50	6	58		-	9	16	44	6	13	6	242
7	Kurdistan	-	24	-	-		-	-	-	-	-	-	-	24
8	Tehran	-	-	15	-		-	-	-	-	-	-	-	15
9	Swedish	-	-	-	24		-	-	15	-	25	45	-	109
10	Paki	-	-	-	-		-	-	18	-	55	68	79	220
11	Dayik	-	-	-	-		-	53	49	78	88	125	134	527
12	Anatolia	-	-	-	-		-	-	-	28	8	-	-	36
13	eye centre	-	-	-	-		-	2	-	-	11	-	-	13
14	eye teaching	-	-	-	-		-	-	4	-	-	-	-	4
15	Hawler	-	-	-	-		-	-	100	12	-	70	-	182
16	Sami	-	-	-	-		-	-	-	-	-	2	6	8
17	Soma	-	-	-	-		-	-	-	-	-	40	-	40
18	welfer	-	-	-	-		10	-	-	-	20	-	-	30
19	Lala	-	-	-	-		-	-	-	-	-	-	42	42
20	Rmsi company	-	-	-	-		-	-	-	-	-	-	22	22
21	IMC	-	-	-	-	520	50	-	-	2	-	-	-	625
22	Zheen	-	-	-	-	-	84	121	77	-	-	-	-	282
23	Media centre	-	-	-	-	-	-	-	46	85	81	-	-	212
24	Zhyan	73	89	221	984	656	40	22	50	321	110	21	-	2587
25	Emergency	22	-	-	-	33	-	-	51	-	38	88	-	232
26	Nanekeli	64	94	160	134	375	449	124	244	242	120	391	-	2397
27	Zanko	65	82	10	74	72	73	-	40	33	22	78	-	549
28	Azadi	22	27	8	20	57	14	44	35	62	36	142	55	522
29	Shadi	22	70	13	-	43	83	33	32	47	18	69	15	445
30	Mala-fandi	169	74	20	-	-	39	29	-	-	-	73	25	429
31	Nawroz	49	62	15	177	36	76	23	21	62	30	79	36	666
32	heart centre	-	222	-	-	107	31	43	192	244	82	-	220	1141

Appendix 1 continued

Medical hazardous waste generation from hospitals year 2015

33	Rizgary	-	-	27	-	50	-	-	-	42	60	42	-	221
34	Ahmed bajalan	-	-	10	-	-	80	-	-	33	27	62	-	212
35	Mamun dabagh	-	-	20	-	-	50	20	16	82	-	-	-	188
36	Family	-	-	-	-	-	-	-	-	-	-	8	-	8
37	Layla qasm	-	-	-	-	-	-	-	-	-	-	127	32	159
38	Western	-	-	-	-	39	-	-	-	87	-	-	1500	1626
39	Airport	-	-	-	-	-	-	-	-	-	-	-	10	10
40	Soran	-	-	-	-	49	-	-	-	-	-	-	-	49
41	DBB-Erbil	961	743	531	2775	3702	365	435	539	450	425	406	-	11332
42	Tayrawa	67	115	193	440	769	66	35	33	36	-	50	-	1804
43	Nazdar bamarny	20	81	258	-	-	-	-	45	30	-	-	-	434
44	Sarwaran	25	27	-	200	912	62	30	17	-	43	21	-	1337
45	central lab.	170	-	-	-	-	-	-	-	-	-	-	-	170
46	Raparin	20	-	-	572	65	95	-	3	-	12	31	-	798
47	Talasimia	44	70	17	296	344	138	92	23	53	33	47	-	1157
48	childbirth	53	-	-	1000	560	180	-	120	311	408	988	-	3620
49	Erbil health directorate	-	108	190	45	657	72	65	49	68	73	66	-	1393
50	Refugee camp	-	139	60	-	-	-	-	-	-	-	-	-	199
51	Chest and respiratory centre	-	22	-	-	522	-	-	-	21	-	-	-	565
52	Kuran-ainkawa	-	-	-	-	100	-	-	-	-	-	-	-	100
53	West Erbil	-	-	-	-	-	27	-	45	-	-	-	-	72
54	pharmacy dept.	-	-	-	-	-	-	-	-	33	-	21	-	54
55	Rojhalat emergency	-	-	-	-	-	-	-	-	-	30	-	-	30
56	doctors without borders	-	-	-	-	-	-	-	-	-	15	-	-	15
57	educational for children	-	-	-	-	-	-	-	-	-	-	21	-	21

Appendix 2
Medical hazardous waste generation from hospitals year 2016

No.	hospital names	Jan	Feb	Mar	Ap	May	june	july	Aug	sep	oct	Nov	Dec	Total (2016)
		Kg	Kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg/yr
1	par													0
2	west eye													0
3	Noor	-	-	-	-	-	-	-	-	-	-	-	-	0
4	Sardam	24	-	-	100	-	-	-	200	-	-	-	-	324
5	rasul	-	-	-	-	-	-	-	-	-	-	-	-	0
6	sima	13	-	11	6	6	42.5	1625	2	7	4	4	4	1682
7	Tehran	-	-	-	-	-	-	-	3	-	-	-	-	3
8	paki	228	-	115	60	73	40	45	65	84	40	100	28	878
9	daiyk	119	-	164	68	190	45	114	248	147	131	87	42	1310
10	Anatolia	-	-	-	-	-	-	-	-	-	-	-	-	0
11	eye centre	-	-	-	-	-	-	-	-	-	-	-	-	0
12	eye teaching	-	-	44	-	-	-	-	2	-	45	2	-	48
13	Shami	-	-	-	-	-	-	-	-	-	-	-	-	0
14	Soma	-	-	-	-	-	-	-	-	-	-	-	-	0
15	Lala	10	-	-	-	-	-	7	6750	-	-	2	-	6769
16	Rimas	-	-	4	-	-	-	90	-	-	-	-	-	94
17	Shifa	-	-	-	-	-	-	-	-	-	-	-	2	2
18	IMC	-	-	-	-	32	-	-	-	-	45	25	25	127
19	Zheen	-	-	208	-	-	-	68	195	181	392	376	130	1550
20	Hawler	-	-	31	-	25	-	30	25	20	-	30	65	226
21	Emergency	35	-	-	80	50	50	20	-	15	14	15	68	347
22	Nanekeli	250	-	353	200	88	47	80	90	70	75	75	50	1378
23	Zanko	23	-	-	-	28	45	-	-	-	-	-	-	96
24	Azadi	60	-	55	30	-	25	-	-	80	65	30	40	385
25	Shadi	28	-	12	10	50	45	20	29	19	10	32	10	265
26	mala-fandi	27	-	15	12	22	-	-	-	-	-	-	-	76
27	Newroz	12	-	22	36	7	40	10	16	33	15	24	18	233
28	heart surgery centre	278	-	330	352	249	200	130	281	115	391	240	24	2590
29	Rizgary	15	-	166	-	305	32	20	60	25	40	30	30	723
30	Mohammed bajalan	-	-	25	-	-	-	10	15	-	-	-	-	50
31	Mamun dabagh	22	-	-	20	25	-	-	-	-	-	20	-	87
32	family	-	-	-	-	-	-	-	-	-	-	-	-	0
33	Layla Qasim	31	-	-	14	49	21	6	26	24	15	-	-	186
34	western hospital	-	-	-	-	-	-	-	-	-	-	-	500	500

Appendix 2 continued

Medical hazardous waste generation from hospitals year 2016

35	blood centre	266	-	405	710	542	545	325	585	385	540	650	587	5540
36	nafih Akreyi	12	-	17	24	62	35	29	25	36	66	40	60	406
37	Kurdistan	-	-	-	6	17	26	9	422	4	25	18	16	121
38	Airport	-	-	-	-	30	23	-	53	8	-	11	-	125
39	Shakra	-	-	-	-	55	-	-	-	-	-	-	-	55
40	Shahidan	-	-	-	-	-	-	-	-	-	10	-	-	10
41	centre of skin	-	-	-	-	-	-	-	-	-	-	4	-	4
42	DBB-blood bank	-	-	502	-	465	-	249	386	435	399	485	197	3118
43	Tayrawa	-	-	11	-	261	-	53	18	14	94	40	-	491
44	Nazdar bamarni	-	-	-	-	33	-	26	22	-	72	-	17	170
45	sarwaran	-	-	-	-	23	-	-	8	-	-	-	-	31
46	central lab	-	-	-	-	-	-	-	-	-	-	-	-	0
47	medical centre	-	-	-	-	-	-	-	-	-	-	-	-	0
48	zhyan	-	-	21	-	50	-	29	17	24	24	60	48	273
49	Raparin	-	-	-	-	-	-	-	25	-	165	350	430	970
50	talasimia	-	-	-	-	96	-	60	32	25	-	80	77	370
51	childbirth	-	-	367	-	697	-	641	48	608	531	629	393	3914
52	Erbil health directorate	-	-	9	-	273	-	42	27	20	72	40	67	550
53	Refugee camp	-	-	-	-	-	-	-	-	-	-	-	-	0
54	Chest and respiratory centre	-	-	-	-	-	-	-	12	-	-	-	-	12
55	Kuran-ainkawa	-	-	-	-	-	-	-	-	-	-	-	-	0
56	emergency	-	-	4	-	37	-	-	-	-	-	-	35	76
57	psychological	-	-	-	-	-	-	-	-	-	-	20	-	20
58	Rojhalat	-	-	-	-	-	-	-	-	-	-	-	-	0
59	Ministry of health	-	-	-	-	17	-	-	-	-	-	-	14	31

Appendix 3
Medical hazardous waste generation from hospitals year 2017

No.	Hospital name	Jan	Feb	Mar	Ap	May	june	july	Aug	sep	oct	Nov	Dec	Total (2017)
		Kg	Kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg/yr
1	westeye													0
2	noor	-	-	-	-	-	-	-	-	-	-			0
3	sardam	-	-	153	-	-	-	-	122	43	-	42	37	397
4	sima	5	2	6	5	4	-	8	20	12	-	13	11	86
5	paky	-	20	50	-	70	-	-	76	44	-	36	54	350
6	mother	80	60	151	112	72	-	49	27	11	-	45	32	639
7	eye centre	-	-	5	-	-	-	-	-	-	-	-	-	5
8	eye teaching	-	2	-	-	2	-	-	4	2	-	-	4	13
9	Lala	-	-	-	-	-	-	-	-	-	-	-	5	5
10	Shifa	-	-	-	6	-	-	7	-	4	-	-	4	17
11	Marvin	-	-	-	2	-	-	-	-	-	-	-	-	2
12	Kurdistan	-	-	-	-	-	-	18	-	-	-	-	-	18
13	RMSI	-	-	-	-	-	-	25	-	-	-	-	-	25
14	SHAR	-	-	-	-	-	-	-	-	-	-	-	5	5
15	media centre	-	-	-	-	-	-	-	-	-	-	30	18	48
16	emergency	23	60	-	-	-	-	-	-	-	53	-	-	136
17	nanekeli	29	85	5	-	-	-	-	-	-	-	-	-	119
18	Azadi	25	-	10	-	-	-	-	-	-	-	-	-	35
19	shadi	26	10	75	15	-	-	10	24	24	-	-	-	184
20	newroz	18	8	36	-	-	-	35	50	16	-	-	-	163
21	heart centre	255	470	320	161	317	-	-	224	128	198	213	-	2286
22	Rizgary	50	45	42	135	30	-	30	-	-	30	6	-	368
23	Layla Qasim	28	20	40	40	-	-	80	17	7	-	40	-	272
24	blood centre	791	508	643	541	607	-	345	-	-	242	463	-	4140
25	nafih akreyi	23	16	20	11	26	-	18	83	45	55	20	-	317
26	airport	29	40	-	-	-	-	80	-	-	-	-	-	149
27	Khazar	-	85	35	-	-	-	-	-	-	-	-	-	120
28	shahidan	-	-	45	-	-	-	-	-	-	-	-	-	45
29	harsham camp	-	-	-	71	-	-	-	-	-	-	-	-	71
30	teer company	388	26	51	127	56	44	15	27	13	17	6	10	736
31	Ncciraq	10	-	-	-	-	-	-	-	-	-	-	-	10
32	zheen	180	66	103	133	128	28	192	83	84	45	72	93	1207
33	hawler	30	18	46	39	49	-	41	74	38	30	45	34	444
34	zhyan	-	-	-	27	-	-	-	-	-	-	-	-	27
35	par	25	15	12	-	29	-	58	30	44	14	18	38	283
36	welfer	15	8	13	5	8	5	4	2	8	8	2	7	83
37	Istanbul	-	5	-	-	-	-	-	-	-	-	-	-	5
38	doctors without borders	150	-	-	60	-	-	-	-	-	-	-	-	210
39	rasul	-	-	-	7	-	-	-	-	-	-	22	36	65
40	Rahma	43	4	8	4	3	-	2	3	1	2	-	1,6	70
41	bahirka camp	30	27	-	-	-	-	-	-	-	-	-	-	57
42	western pharmacy	3	-	-	-	-	-	-	-	-	-	-	-	3

Appendix 3 continued
Medical hazardous waste generation from hospitals year 2017

43	medical university	-	10	-	-	-	-	-	-	-	-	-	-	10
44	shar	-	10	-	-	-	-	-	-	-	-	-	-	10
45	runahi centre	-	-	44	-	-	18	15	-	-	30	-	-	107
46	KHC company	-	-	-	-	999	-	-	-	-	-	-	-	999
47	mayser medical company	-	-	-	-	1	-	200	40	-	-	-	19	260
48	green hiber	-	-	-	-	-	20	-	-	-	-	-	-	20
49	child protection organization	-	-	-	-	-	250	-	-	-	-	-	-	250
50	umia company	-	-	-	-	-	-	180	-	-	-	-	-	180
51	ecology company	-	-	-	-	-	-	5	51	46	79	16	18	215
52	Triskan organization	-	-	-	-	-	-	56	-	-	-	-	-	56
53	Ayla centre	-	-	-	-	-	-	1	-	-	1	-	1	3
54	niga centre	-	-	-	-	-	-	-	2900	-	-	-	2,4	2900
55	American eye centre	-	-	-	-	-	-	-	-	20	3	-	2,4	23
56	DBB- blood bank	-	554	574	686	-	223	207	682	409	-	-	-	3335
57	tayrawa	10	10	18	41	-	-	72	81	40	122	98	32	524
58	nazdar bamarny	50	23	17	109	-	-	38	94	-	34	-	28	393
59	sarwaran	20	-	-	-	-	-	-	-	-	-	-	-	20
60	hawler teaching centre	50	-	-	54	-	12	-	72	-	47	-	-	235
61	DBB- blood bank	615	-	-	-	-	-	89	609	464	173	290	163,3	2240
62	zhyan	70	25	25	95	-	15	54	62	47	43	54	63	553
63	mala-fandy	-	-	-	-	-	-	-	-	-	-	-	-	0
64	raparin	350	330	174	100	-	-	-	80	10	-	-	50	1094
65	talasimia	60	122	65	135	-	40	70	87	95	73	67	64	878
66	childbirth	649	-	50	-	-	-	-	-	-	-	-	-	699
67	central lab.	110	170	142	75	-	50	332	180	210	113	86	143	1611
68	clinical centres	15	-	-	-	-	-	-	-	-	-	-	-	15
69	chest and surgical centre	-	17	15	-	-	-	-	-	-	-	-	-	32
70	kuran-ainkawa	-	-	-	-	-	-	-	-	-	-	-	-	0
71	emergency	20	-	35	-	-	-	-	-	-	-	-	-	55
72	psychological	-	-	-	-	-	-	162	-	-	-	-	33	195
73	rojhalat	-	-	120	-	-	-	-	14	-	25	-	-	159
74	Ministry of health	12	-	-	-	-	-	-	-	-	-	-	-	12
75	Mamun dabagh	15	20	15	20	-	10	-	30	11	-	11	50	182

Appendix 3 continued
Medical hazardous waste generation from hospitals year 2017

76	talasimia-ainkawa	-	-	25	-	-	-	-	-	-	-	-	-	25
77	pirzin	-	-	-	-	-	-	65	-	-	-	-	-	65
78	talasimia	-	-	-	-	-	-	155	-	-	-	-	-	155
79	khanzad	-	-	-	-	-	-	-	-	17	24	16		57
80	kasnazan	-	-	-	-	-	-	-	-	19	-	56	9	84
81	shahid Najeeb	-	-	-	-	-	-	-	-	-	-	22	-	22
82	shawes	-	-	-	-	-	-	-	-	-	-	18	-	18

Appendix 4
Medical hazardous waste generation from hospitals year 2018

No	Hospital name	Jan	Feb	Mar	Ap	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (2018)
		Kg	Kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg/yr
1	westeye							12	6	8		7	8	41
2	sardam	37	12	13	15	21		48	34	45		11	36	271
3	rasul		13	71										83
4	sima	10	26		17	6	6			25		6	7	102
5	paky	32		60	169	248	101	183	50	148		159	135	1285
6	mother	40		12	16	15	13	13	4	19		19	19	170
7	eye teaching		6	4	13	6			1					30
8	Shami		4											4
9	Lala private			19	15	13	5	9	17	5		33	16	132
10	Shifa			5	9		3	2	3	5		5	6	38
11	rmsi											115		115
12	shar				20			9		10		15	22	76
13	media centre	20		35	58	52	9	43	47	29		30	85	408
14	welfer			5										5
15	alim university		72											72
16	knowledge university		10			38								48
17	zanko					6			4			7		17
18	double heat							6						6
19	Lebanon									12				12
20	balsam									11		11		22
21	dama organization									125				125
22	English village									20				20
23	step											23		23
24	barza company												39	39
25	Swedish												40	40
26	Azadi		22	20	17	20			18					97
27	shadi		49	45	22	26	16	25	9	9				201
28	heart centre	213	215	170	194	336	166	300	162	162				1918
29	Rizgary	6	35	26	35	35	5	33	244	18				437

Appendix 4 continued

Medical hazardous waste generation from hospitals year 2018

30	Layla Qasim	40	33	21	15	35	65	38	98	98				443
31	western emergency		346	19	13									378
32	blood centre	463	296	150	25	416	251	605	345	345				2896
33	nafih akreyi	10	28	15	15	16	8	40	43	43				218
34	Kurdistan	20	50	20	17	15								122
35	shahidan							10						10
36	hawler medical					4		1						5
37	industrial kidney centre								245	245				490
38	teer company				156	230,1	278	277	356	326	278	163	203	2037
39	IMC				20									20
40	zheen				136	85	82	174	107	165	106	141	106	1102
41	haawler				20	82	26	18	37	23	23		21	250
42	media centre				58			47	50			30		185
43	par				144	95	120	125	38	135	96	89	50	892
44	welfer				2	3	3	7	9	4	9	8	4	49
45	rasul				47	29	25	44	41	43	25	29	11	294
46	Rahma					2								2
47	American medical								8	18			23	49
48	runahi							50				50		100
49	mayser company					130						17		147
50	medical organization				25			25				42		92
51	Ayla centre									3				3
52	niga centre				2							4		6
53	American eye centre				4									4
54	US consulate general Erbil				28	28								56
55	medical clinic				3									3
56	hawler medical centre							3						3
57	daghr clinic									6				6
58	Cooperative medical organization										132			132
59	beauty centre										2	1	2	5
60	cente rsharqeye										2	2		4
61	DBB-Blood bank							222						222
62	tayrawa				75	24	20	38		56	51	36	3	303
63	nazdar bamarny				32	38	20	33	13	48	8	16	8	216
64	sarwaran									16	15			31
65	hawler medical						122	28		16	190			356
66	blood bank					470	500							970
67	zhyan				28	56	20			72	14	5	10	205

Appendix 4 continued
Medical hazardous waste generation from hospitals year 2018

68	raparin						200			160	220	200	180	960
69	talasimia				26	242	232	162		114	370	170	190	1506
70	hawler medical centre				11	450	400	473		265	474	250	260	2583
71	kuran-ainkawa										2	10		12
72	rojhalat emergency					72	153							225
73	Mamun dabagh					4	30	40		35	20		25	154
74	talasimia-ainkawa						81							81
75	pirzin									22			60	82
76	talasimia centre							162						162
77	khanzad				38					42				80
78	kaznazan						58							58
79	shahed dr. Habib				11	14	11			21	37	15	7	117
80	Mohammed bajalan									32		11	25	68
81	brayaty									20				20
82	ainkawa									46	40	10	10	106
83	health office												60	60

Appendix 5
Medical hazardous waste generation from hospitals year 2019

No	Hospital name	Jan	Feb	Mar	Ap	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (2019)
		Kg	Kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg/yr
1	westeye	20	7	8	8	20	7	7	8	7	2	5		99
2	sardam	38	12	61	11	61	18	26	19	39	17	18	53	373
3	sima	3						4		7	6			20
4	paky	102	95	150	199	68	88	20	17	62	46		30	877
5	mother			19	19	38	9	19	19		19	19	19	180
6	eye	2							2			2	9	15
7	soma			30						25				55
8	Lala	36	13	34	28	12	4		15	5	11	16	23	197
9	Shifa	3	6	5	7	7		7	5	6		5	7	58
10	RMSI		29			5								34
11	shar		18		13		16	17	10		25	10		109
12	media centre	54	78	131	63	80	44	60	49	91	47	61	32	790
13	knowledge university									10				10
14	zanko		16										22	38
15	balsam	55						25			27			107
16	step				30									30
17	new vision eye				2	11								13
18	honia clinic						12							12
19	Shet bn Clinic							15						15
20	IMC							10	44					54

Appendix 5 continued

Medical hazardous waste generation from hospitals year 2019

21	IOM									3				3
22	bouble hair										5			5
23	Azadi	15	20	15	60	45	59	32	32	25	18	51		372
24	shady	11	30	20	55	47	54	27	27				26	297
25	heart centre	134	110	130	205	846	1159	1698		110	240	5460	336	10428
26	Rizgary	80	114	280	220	2700	2967	550	73	73	2210	2700	35	12002
27	Layla Qasim	65	50	50	70	35	62	86	35	20	16	27	60	576
28	blood centre	415	500	60045	680	950	950	1087						64627
29	nafih akreyi	43	30	45	60	80	73	35	35	10	18	428	20	877
30	kurdistan												15	15
31	hawler teaching medical centre												1500	1500
32	industrial kidney centre	202		302	700	1500	2580	2850	20000	2400	2550	2847	2750	38681
33	teer company	152	43											195
34	zheen	151	153		203			115	123	149	69		127	1090
35	Hawler	163	17		20					28			487	715
36	Swedish private												57	57
37	par	66	72		70			133	107	214	138		140	940
38	welfer	6	8		5			133	73	51	4		41	320
39	CMC		24		24			45			47		23	163
40	Rasul	37						16		62	46		35	196
41	Rahma							1						1
42	American university								12					12
43	shar		18											18
44	runahi centre		31										40	71
45	mayser												30	30
46	doctors without borders										23			23
47	Ayle				3			2						5
48	niga centre												3	3
49	beauty centre	4	13		7			3			4		1	31
50	Sharq for eye				2					1				3
51	LST		55											55
52	new rasul		29		28				17				22	96
53	IMC		29											29
54	shar		580											580
55	balsam				30									30
56	hawler private							23	28		14		377	442

Appendix 5 continued

Medical hazardous waste generation from hospitals year 2019

57	imagine centre							2						2
58	CMC								75		47		23	145
59	hawler hospital for fertility Genetics								4	4				8
60	omer daghir clinic										5			5
61	Marvin beauty										17			17
62	blood bank centre							795	787					1582
63	tayrawa	7	8					13	9	72	382		4	495
64	nazdar bamarny	5												5
65	hawler teaching medical centre		366		250			200	600	1340	1320	910	1957	6943
66	blood bank centre	637	529								1035		1110	3311
67	zhyan	3	4											7
68	raparin		100					132		300		200	90	822
69	talasimia		135		25			225	100	310	100	950	150	1995
70	childbirth	6			25									31
71	hawler medical lab	130	131		60			430	200	340	320	320	260	2191
72	kuran-ainkawa		11					7						18
73	emergency										25			25
74	rojhala		20								295	95	375	785
75	Mamun dabagh	300	35		40			40	8	40		40	50	553
76	pirzin								45			32		77
77	talasimia	135						225						360
78	shahid dr Habib	10	11		13			10	10	21	15	4	3700	3794
79	shawes												4	4
80	Mohammed bajalan							20						20
81	ainkawa	12	53		5			7		48	18	312	215	670
82	chest and surgical breast	65												65
83	darashakran							47				557		604
84	kawrgosk							150				115		265
85	shadi									20				20
86	blood bank centre									1658		775	1110	3543
87	Layla Qasim									80				80
88	Rizgary									45			76	121

Appendix 5 continued
Medical hazardous waste generation from hospitals year 2019

89	kidney centre (west)									400				400
90	shadi									20				20
91	hawler medical centre											80		80
92	Fryakawtni nawand												76	76

Appendix 6
Medical hazardous waste generation from hospitals year 2020

No.	Hospital names	Jan	Feb	Mar	Ap	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (2020)
		Kg	Kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg/yr
1	media	86	20		11	155	84	86						356
2	sardam	65	15		79	47	39	65						245
3	Shifa	7	7											14
4	westeye	11	6											17
5	mother	19	29			20	20							88
6	paky	41				24								65
7	Rmsi	40												40
8	Shar	19												19
9	Lala	16	12	15										33
10	balsam	27	100	70										134
11	awamedica	388												388
12	eye		11											11
13	IOM		29											29
14	sima		5											5
15	double hair		5											5
16	RWA		2											2
17	shayda beuty		3			10								13
18	shar		46				20							66
19	IMC						15							15
20	Layla	35												35
21	heart centre	4500												4500
22	nafih Akreyi	55												55
23	shadi	15												15
24	Azadi	45												45
25	industrial kidney	6000												6000
26	hawler private	484	655											1139
27	zheen	154	173											327
28	Santa maria	16												16
29	new rasul	48	30											78
30	CMC	55	27											82
31	mayser company	13												13
32	local medical	4												4
33	beauty centre	5												5
34	welfer	27	20											47
35	par	123	81											204
36	sharq		1											1

Appendix 6 continued
Medical hazardous waste generation from hospitals year 2020

37	LST		46											46
38	blood bank	640	390											1030
39	general medical centre	80	240											320
40	rojhalat centre	310	15											325
41	talasimia	235	70											305
42	kawrgosk	75												75
43	ainkawa	10	2											12
44	shahid dr Habib	5	3											7
45	hawler medical		2415											2415
46	shaqlawa		74											74
47	raparin		50											50
48	sarwaran		42											42
49	pirzin					11								11
50	par/corona									417				417
51	tayrawa									155				155
52	brayati									60				60
53	shahid Salih									4				4

Upravljanje bolničkim otpadom: tretman, skladištenje i odlaganje

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INFORMACIJE O RADU

Primljen 03 avgust 2021
Prihvaćen 03 mart 2022

Originalni rad

Ključne reči:
Bolnica
Otpad
Erbil
Menadžment
Životna sredina

I Z V O D

Brzi porast broja stanovnika, industralizacija i rast potražnje za sirovinama za industrijsku i medicinsku proizvodnju su doveli do stvaranja velike količine opasnog otpada. Opasan otpad se identifikuje prema svojoj toksičnosti, zapaljivosti i radioktivnosti. Odlaganje opasnog otpada u prirodnu sredinu ima značajan uticaj na zdravlje i sva živa bića u životnoj sredini. Danas veliki broj bolnica i industrijskih pogona stvara velike količine opasnog otpada. Cilj ovog rada je procena sistema upravljanja opasnim bolničkim otpadom u Erbilu. Pored toga, fokus je na upravljanju opasnim bolničkim otpadom i karakterizaciji i stanju u Erbilu. Stopa proizvodnje opasnog otpada iz bolnica u Erbilu je prikupljena za 12 meseci, u periodu od 2015. do 2020. godine. Rezultati su pokazali da je najveća količina ovog otpada nastala tokom 2019. godine. Štaviše, potrebno je povećati broj centara za spaljivanje otpada na licu mesta kao bi se smanjili troškovi skladištenja i transporta.