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Estimation of Current and Future Generation of Medical Solid Wastes In Hanoi City, Vietnam

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Abstract

Management of medical waste is of great importance due to its infectious and hazardous nature that can cause adverse impacts on human health and environment. The objectives of this study were to estimate the current generation of medical solid waste and its existing management practices in Hanoi city, Vietnam. This study also aimed at providing the predictions for future generation of medical solid waste that could serve as scientific basis for planning of medical waste management in Hanoi city. Based on the collected secondary data, the analyses indicated that the generation rate of total medical waste (including normal and hazardous medical waste) is 0.86 kg/bed.day, in which the generation rate of hazardous medical waste is 0.14 kg/bed.day. The major problem associated with existing management practices of medical waste is the treatment and disposal stage. There are no official recycling activities for normal medical waste at present although its legal basis has been setting up in the Medical Waste Management Regulation in 2007 issued by Ministry of Health. With respect to the treatment of hazardous medical waste, incinerators-the major applied technology are being operated inefficiently. For overcoming these obstacles, the local government and relating agencies need to put more effort, in terms of financial and human resources, in facilitating the official recycling activities for normal medical waste and developing more environmentally-friendly alternative treatment technologies for medical waste, towards the gradual replacement of unnecessary incineration. The study predicted that in 2020 and 2030, the quantities of total medical waste generated in Hanoi city would be 30.44 and 46.05 tons/day, respectively which 1.7 and 2.6 times higher than those in 2010. This would be challenging the local government in managing medical waste generated in the future.

Keywords: Medical solid waste management; Normal medical waste; Hazardous medical waste; Prediction; Hanoi city

Introduction

Recently, there has been an increase in the public concern about the management of medical waste on a global basis [1]. Medical wastes are considered as a special category of waste because they pose potential human health and environmental risks, as they contain sharps, human tissues or body parts, discarded plastic materials contaminated with blood, discarded medical equipment, and other infectious materials [2]. About 15–25% (by weight) of medical waste is infectious materials [1]. Despite the fact that current medical waste management practices vary from hospital to hospital, the concerning problems are similar for all hospitals and at all stages of management, including segregation, collection, packaging, storage, transport, treatment and disposal [3]. Improper management of medical wastes could cause environmental pollution, unpleasant odors, and growth of insects, rodents and worms. Subsequently, it may lead to transmission of diseases like typhoid, cholera, and hepatitis through injuries from sharps contaminated with human blood [4]. Therefore, it is important to properly manage medical waste to avoid human health and environmental risks.

In Vietnam, especially in the large cities, the rapidly increasing population as well as the increasing healthcare demand in the recent years have led to the enlarging scale of existing hospitals, in terms of the number of sickbed, from 17.7 sickbeds/10,000 people in 2005 to 22 sickbeds/10,000 people in 2009 [5]. This means that the quantities of medical waste generated from hospitals have significantly increased.

Hanoi–the capital city of Vietnam, is the place where the majority of national-level and largest hospitals located. These hospitals are always in the overloaded status since they must receive a large number of patients from most of provinces in the North of Vietnam. Currently, Hanoi has 16 hospitals with the total of 6,680 sickbeds and 16 medical institutes with the total of 1,030 sickbeds that under the management of Ministry of Health. Hanoi also has 15 hospitals with the total of 3,270 sickbeds that under the management of the other ministries such as Ministry of Construction, Ministry of Transportation, Ministry of Industry and Trade, Ministry of Agriculture and Rural Development, Ministry of Public Security, and Ministry of National Defense. In addition, there are 23 provincial-level hospitals, 16 district-level hospitals, 20 private hospitals, and 300 healthcare centers at communal level located in Hanoi city [6]. With a large number of hospitals and healthcare centers concentrated and the rapidly increasing population using the healthcare services, a large quantity of medical waste, including both normal and hazardous medical waste, being generated daily in Hanoi city. On the other hand, according to Hanoi People's Committee [7], the area of Hanoi city will be expanding in the future with newly developed areas, satellite towns, and districts surrounding the existing centre area. The population of these areas will be increased accordingly. As a result, the quantity of medical waste generated will be increased significantly in the future. This study aims at estimating the current generation and evaluating the existing management practices of medical solid wastes in Hanoi city. This study also provides the

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predictions for future generation of medical solid wastes to the years of 2020 and 2030 in Hanoi city which could be used as scientific basis to support the responsible agencies for the management planning of municipal solid waste in general and medical solid waste in particular.

Materials and Methods

Estimation of current generation and management practices of medical waste

Current generation and management practices of medical solid wastes in hospital in Hanoi city are estimated and evaluated basing on the questionnaire survey data and data collected from the secondary sources.

Estimation of future generation of medical waste

Total medical waste generation in the future in Hanoi city is predicted using the following equation:

M=B.R/1000 (ton/day)

Where:

- M: Total medical waste generated (ton/day)

- B: Number of sickbed (bed). According to Hanoi People's Committee [7], there will be 25 sickbeds/10,000 people and 30 sickbeds/10,000 people in Hanoi city in 2020 and 2030, respectively. The predicted population of Hanoi city in 2020 and 2030 is also taken from [7].

- R: Generation rate of medical waste (kg/bed.day), depending on a number of factors such as the increasing rate of population, social-economic condition, types and scales of hospitals, etc. The generation rates of medical waste used in this study are based on the standard for management planning of solid waste issued by Ministry of Construction as the following [8]:

- National-level hospitals: R=2.2 kg/bed.day
- Provincial-level hospitals: R=1.5 kg/bed.day
- District-level hospitals: R=1.0 kg/bed.day

The proportions of normal and hazardous medical wastes are estimated to account for about 80% and 20% of the total medical waste, respectively [8].

Results and Discussions

Current generation of medical wastes

Generation of medical wastes has been continuously increasing due to the increases of number of hospitals and sickbeds, once using medical products, and population in the recent years. On average, the generation rate of total medical waste is 0.86 kg/bed.day, in which the generation rate of hazardous medical waste is 0.14 kg/bed.day [5]. Compared to the other studies around the world, the generation rate of medical waste in this study is higher than those reported for Nanjing city, China [9], Turkey [10], and Korea [11]; comparable to the value estimated for Jordan [4]; however, lower than the values reported for North and South American countries and European countries [12], Greece [3], and Taiwan [13]. The generation rate of hazardous medical waste in this study falls into the range (from 0.01 to 0.65 kg/bed.day) reported for developing countries by Diaz et al. [14]. Actually, the generation rates of medical waste depend on the types and scales of hospital (national-, provincial-, and district-level hospitals), types and scales of units in hospitals, technical operation used, and quantities of materials used as shown in Table 1. Generally, the generation rates of medical waste in different units of national-level hospitals are higher than those of provincial- and district-level hospitals.

Generated quantities of normal and hazardous medical waste of the major hospitals in Hanoi city based on the surveyed data are presented in Table 2. The differences in the hospitals' generated medical waste quantities could be attributed to the differences in the number of sickbed, generation rate of medical wastes, and management practices among the surveyed hospitals.

In medical waste generated from hospitals in Hanoi city, the proportion of recyclable materials is relatively high, ~25% of total mass. Medical waste usually has large organic content (about 52% of total mass) and high moisture. The compositions of medical wastes generated from hospitals in Hanoi city [15] are shown in Table 3.

Segregation and collection of medical wastes

Following the Decision No. 43/2007/QĐ-BYT dated 20 Nov 2007 of Ministry of Health on issuing the Medical Waste Management Regulation [16], medical wastes generated in hospitals are segregated and collected into 4 groups: group A (biomedical wastes), group B (sharp wastes), group C (medicine and chemical wastes), and group D (radioactive wastes). Each group is stored in appropriate facilities such as nylon bag, plastic box, metal box, etc. for subsequent transport and treatment and disposal. Medical wastes are classified to normal and hazardous waste. Normal medical wastes (or non-hazardous wastes) are those do not contain infectious, hazardous chemical, radioactive, explosible elements including general waste generated from patient rooms, wastes generated from medical activities (glass bottle, plastic materials, etc.), and wastes generated from offices (paper, nylon bag, etc.). Hazardous medical wastes are those contain harmful elements for people health such as infectious, radioactive, explosible, and flammable elements. The current status of segregation and collection of medical

Units in hospital	Total medical waste (normal & hazardous) (kg/bed.day)			Hazardous medical waste (kg/bed.day)		
	National-level hospitals	Provincial-level hospitals	District-level hospitals	National-level hospitals	Provincial-level hospitals	District-level hospitals
Intensive care and casualty unit	1.08	1.27	1.00	0.30	0.31	0.18
Medical unit	0.64	0.47	0.45	0.04	0.03	0.02
Child unit	0.50	0.41	0.45	0.04	0.05	0.02
Surgical unit	1.01	0.87	0.73	0.26	0.21	0.17
Maternity unit	0.82	0.95	0.74	0.21	0.22	0.17
Eyes and otorhinolaryngology unit	0.66	0.68	0.34	0.12	0.10	0.08
Clinical unit	0.11	0.10	0.08	0.03	0.03	0.03

Table 1: Generation rate of medical waste in different units of hospitals in Hanoi city.

Hospitals	Number of sickbed (bed)	Normal medical waste (kg/month)	Hazardous medical waste (kg/month)
19-8 hospital	450	NA*	1690
National acupuncture hospital	440	832	NA
E hospital	618	NA	3560
Viet Xo hospital	537	3000	NA
National tuberculosis hospital	400	2400	NA
National child hospital	650	NA	4250
National otorhinolaryngology hospital	250	1000	NA
Traditional hospital	200	NA	80
National scalded hospital	300	NA	740
National malaria hospital	33	NA	62
103 army hospital	650	NA	3000
354 army hospital	250	NA	1022
Xanh Pon general hospital	520	1040	NA
Hanoi tuberculosis hospital	110	1500	500
Hanoi endocrine hospital	242	1200	480
Hanoi heart hospital	70	630	NA
Hanoi protuberance hospital	160	NA	500
North Thang Long hospital	359	1538	636
South Thang Long hospital	100	NA	300
Dong Anh general hospital	2150	NA	700
Dong Da general hospital	270	826	500
Ha Dong general hospital	520	NA	1500
Hoe Nhai general hospital	70	125	26
My Đuc general hospital	150	600	30
Soc Son general hospital	200	NA	260
Van Dinh general hospital	230	750	500
Ba Vi district hospital	200	750	300
Phu Xuyen district hospital	130	NA	150
Phuc Tho district hospital	120	987	210
Thuong Tin district hospital	180	NA	420
Son Tay district hospital	420	2632	1375

*: NA = Not available

Table 2: Generated quantity of normal and hazardous medical waste of hospitals in Hanoi city.

Compositions	% by weight
General waste	26.6-40.0
Packing paper, tissues waste	3.0-9.8
Sharp wastes	1.3-2.3
Blood-contaminated wastes	4.6-18.1
Chemical wastes	1.3-13.8
Plastic waste	2.6-3.2
Metal waste	0.6-1.4
Broken glass bottles	1.8-2.6
Medicine waste	0.1-1.6
Others	12.5-26.0

Table 3: Compositions of medical wastes.

wastes generated in surveyed hospitals of Hanoi city is shown in Table 4 which indicated that for several requirements such as waste containing bag in accordance with standard of color, container with coverage lid, etc., the followed proportions were not really high.

Transportation, treatment and disposal of medical wastes

Currently, medical wastes generated from hospitals in Hanoi city are collected and kept at the storage areas of hospitals. For normal medical wastes, they are then transported to the city's centralized treatment areas by Hanoi Urban Environment One Member Limited Company (URENCO) and mixed with municipal solid wastes for final disposal at landfills. There are no official recycling activities for normal medical wastes at present although its legal basis has been setting up in the Medical Waste Management Regulation [16]. One of the major reasons is the lack of investment capital for constructing and operating treatment systems. For hazardous medical wastes, they are combusted in small incinerators located within hospitals or transported for final treatment in incinerators located in the city's centralized treatment areas. However, the proportion of well-operated incinerators is just about 50% of the total number of installed incinerators at present. The major reasons of inefficient operation of incinerators are the lack of finance, lack of trained human resources, high cost for treatment of generated air pollutants, and high cost of combusting fuels. In the future, incinerators should be gradually replaced with more

environmental-friendly technologies such as autoclave and microwave oven for treatment of hazardous medical wastes.

Prediction of future generation of medical wastes

The prediction results for the generation of total, normal, and hazardous medical wastes from hospitals in Hanoi city to 2020 and 2030 are shown in Tables 5 and 6, respectively. In 2010, the total, normal, and hazardous medical waste quantities generated in Hanoi city were reported to be 18, 13.5, and 4.5 tons/day, respectively [17]. Therefore, the generated quantities of total, normal, and hazardous medical wastes in 2020 would be about 1.7, 1.8, and 1.4 times higher than those in 2010, respectively. Meanwhile, the generated quantities of total, normal, and hazardous medical wastes in 2030 would be about 2.6, 2.7, and 2.0 times higher than those in 2010, respectively. This would be challenging the local government in managing medical waste generated in the future.

Clearly, the quantities of medical wastes generated in the urban areas are much higher than those in the rural areas, for instance, 3.6 and 4.3 times higher for prediction results in 2020 and 2030, respectively. The reason is that the population and generation rate of medical waste assumed for the urban areas were about 2 times higher than those for the rural areas.

Within the urban areas, the predictions show that the quantities of medical wastes generated in the centre areas are 7.6 and 39.7 times higher than those in the satellite towns and districts in 2020. Meanwhile, in 2030, the quantities of medical wastes generated in the centre areas are predicted to be 4.9 and 42.8 times higher than those in the satellite towns and districts. These imply that in the longer term, the more development of the satellite towns surrounding the city centre, particularly their increasing population is the major cause for the significant increase in the quantity of medical wastes generated in these areas. Whereas, the prediction for the districts shows the lower increasing rate of medical wastes, mainly due to the lower increasing rate of population in these areas.

Conclusions and Recommendations

With a large number of hospitals and healthcare centers concentrated and the rapidly increasing population using the healthcare services, a large quantity of medical waste, including both normal and hazardous medical waste, is being generated daily in Hanoi city. Moreover, with the future enlargement, in terms of area and population, the future generation of medical waste would be significantly increased. In conclusion, the main findings of this study are:

• The generation rate of total medical waste (including normal and hazardous medical waste) is 0.86 kg/bed.day, in which the generation rate of hazardous medical waste is 0.14 kg/bed.day.

Medical Waste Management Regulation	Followed proportion (%)
Waste containing bag in accordance with standard of thickness and volume	66.67
Waste containing bag in accordance with standard of color	30.67
Waste containing bag in accordance with standard of packing	81.33
Sharp waste containing box in accordance with standard	93.90
Container with coverage lid	58.33
Container with label	66.67

Table 4: Current status of segregation and collection of medical wastes.

No	Area	Population* (1,000 people)	Number of sickbed/10,000 people (bed)	Total number of sickbed (bed)	Generation rate of medical waste (kg/bed.day)	Total medical waste (ton/day)	Normal medical waste (ton/day)	Hazardous medical waste (ton/day)
1	Urban areas	4,676.8	25	11,692	-	23.84	19.07	4.77
1.1	Centre areas	3,748.3	25	9,371	2.2	20.62	16.49	4.12
1.1.1	Inner areas	1,727.8	25	4,320	2.2	9.50	7.60	1.90
1.1.2	Newly developed areas	2,020.5	25	5,051	2.2	11.11	8.89	2.22
1.2	Satellite towns	722.2	25	1,806	1.5	2.71	2.17	0.54
1.3	Districts	206.2	25	516	1.0	0.52	0.41	0.10
2	Rural areas	2,642	25	6,605	1.0	6.61	5.28	1.32
3	Hanoi city	7,318.8	25	18,297	-	30.44	24.36	6.09

*: Data taken from 6. Hanoi Department of Health [6]

Table 5: Prediction of medical waste generation to 2020 in Hanoi city.

No	Area	Population* (1,000 people)	Number of sickbed /10,000 people (bed)	Total number of sickbed (bed)	Generation rate of medical waste (kg/bed.day)	Total medical waste (ton/day)	Normal medical waste (ton/day)	Hazardous medical waste (ton/day)
1	Urban areas	6,218.5	30	18,656	-	37.30	29.84	7.46
1.1	Centre areas	4,606	30	13,818	2.2	30.40	24.32	6.08
1.1.1	Inner areas	1,656	30	4,968	2.2	10.93	8.74	2.19
1.1.2	Newly developed areas	2,950	30	8,850	2.2	19.47	15.58	3.89
1.2	Satellite towns	1,377	30	4,131	1.5	6.20	4.96	1.24
1.3	Districts	235.4	30	706	1.0	0.71	0.56	0.14
2	Rural areas	2,917	30	8,751	1.0	8.75	7.00	1.75
3	Hanoi city	9,135.5	30	27,407	-	46.05	36.84	9.21

*: Data taken from Hanoi Department of Health [6].

Table 6: Prediction of medical waste generation to 2030 in Hanoi city.

• In 2010, the total, normal, and hazardous medical waste quantities generated in Hanoi city were 18, 13.5, and 4.5 tons/day, respectively.

• In 2020, the total, normal, and hazardous medical waste quantities generated in Hanoi city predicted to be 30.44, 24.36, and 6.09 tons/day, respectively.

• In 2030, the total, normal, and hazardous medical waste quantities generated in Hanoi city predicted to be 46.05, 36.84, and 9.21 tons/day, respectively.

Although the Ministry of Health has issued the Medical Waste Management Regulation in 2007 aiming to ensure appropriate handling and processing of medical waste, there is still need to put the regulations into practice, for example, those related to the treatment and disposal of medical waste. For maximizing the health and environmental benefits, the local government and relating agencies should put more effort in the facilitation of the official recycling activities for normal medical wastes. The recycling and reuse of normal medical waste materials are very important in reducing the waste generation as well as disposal cost. Currently, many hospitals in developed countries like USA, UK are operating recycling program to recycle uncontaminated solid waste materials like office paper, cardboard, metal cans and selected glass [18,19]. For successful recycling program, it is important to promote separation of medical waste components at the source. In addition, development and application of more environmentally friendly alternative treatment technologies for medical waste (e.g. microwave sanitation, autoclave, chemical disinfection, pyrolysis, and gasification) should be encouraged, towards the gradual replacement of unnecessary incineration. For example, estimated that microwaving medical waste might be economically competitive compared to the incinerator [20].

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