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ASSESSMENT OF HEALTHCARE SOLID WASTE MANAGEMENT IN LONG XUYEN CITY, AN GIANG PROVINCE, VIETNAM

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ABSTRACT

Management of healthcare solid waste, especially hazardous medical waste, is an important and necessary action due to its potential risks to the environment and public health. In recent years, environmental protection and management agencies have made great efforts when combining waste collection, treatment, and management. In this study, the current situation of generation, management, collection, and treatment of healthcare waste, especially hazardous medical waste, of hospitals in Long Xuyen City, An Giang Province (Vietnam) was surveyed via site investigation, survey, and questionnaire. Hazardous medical waste, which accounts for 21% of total healthcare waste, is mainly generated in central hospitals, especially for An Giang Central General Hospital with about 103 kg/day. Almost all of the healthcare waste is segregated at the source, contained, and stored in standard containers. In hazardous medical waste, the infectious one accounted for 99.11% of the total amount of hazardous medical waste generated. After collection, most hazardous medical wastes are brought to Binh Duc landfill by special vehicles for burning and treatment while Hanh Phuc hospital treats the waste itself by a dedicated incinerator. Although the management in the Long Xuyen city area is relatively good, there are still some shortcomings that need improvements such as state policies, operation of treatment systems, and quality control of post-treated waste. Therefore, several solutions have been proposed to improve the management and treatment of hazardous medical waste in this area, which could be also applied in other regions of Vietnam.

KEYWORDS: hazards medical waste; health-care solid waste management; Long Xuyen City

1. Introduction

In Vietnam, the development of the country requires an increasingly high quality of life, where health care is one of the people's top priorities, resulting in a rapid increase in the number of hospitals and clinics [1]. These activities lead to the generation

of healthcare solid waste (HCW) into the environment, including ordinary solid waste (OSW) and hazardous medical waste (HMW) in solid, liquid, and gaseous forms [2] In particular, HMW contains microbiological agents, radioactive substances, chemicals, heavy metals, and cytotoxic toxins, which have severely negative impacts on the environment and human health, especially with those in direct contact [3]. HMW requires special treatment before disposal since it has a fast rate of infection, is difficult to control, and has dangerous consequences for humans and the environment [4].

In general, the management of HCW in Vietnam is still not strict, where the problem of classification, collection, and treatment has not met the technical requirements [5, 6]. More dangerously, there is still HMW found in the composition of domestic wastes, which silently affects the environment and the health of the community in the hospital and dumping area. As of 2015, the whole country had about 13,725 central and local hospitals; however, there were only 200 specialized medical waste incinerators. These facilities are concentrated mainly in the provincial hospitals with large incinerators in Hanoi and Ho Chi Minh City and the rest are medium-sized and small-sized ones, which are hard to be controlled and monitored [7]. Generally, more than 300 tons of HCW are generated every day across the country and the new incinerators serve about 40% of the total number of hospitals. Among them, around one-third of solid waste is burned with modern electric incinerators that can ensure environmental safety [8].

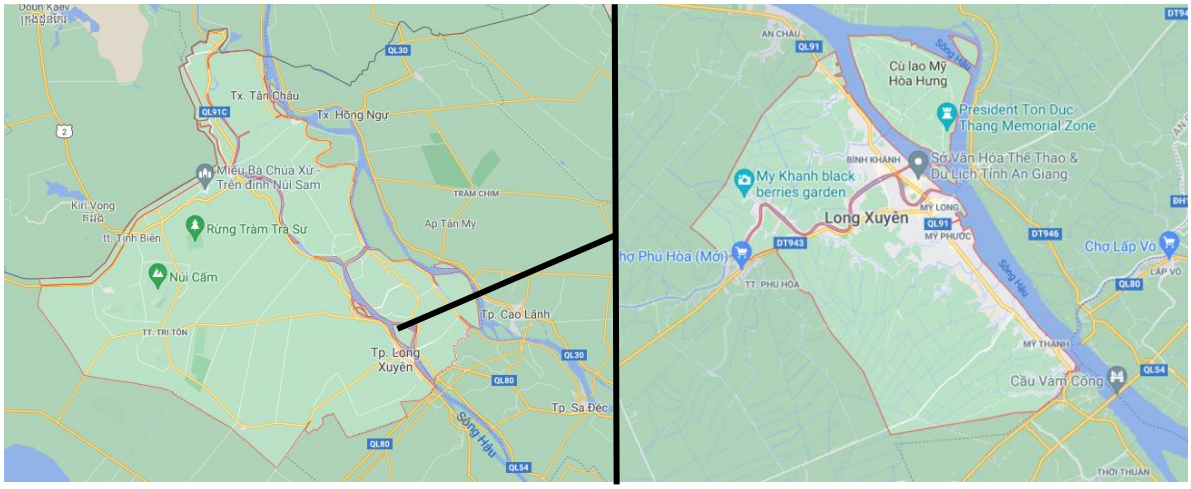
An Giang Province has more than 500 large and small hospitals with an HCW generation of about 392,298 kg/year. It ranks 7th in Vietnam of HMW generation [9]. In Long Xuyen City, there are 7 large hospitals and 13 small local hospitals with a total HMW generation of more than 93,000 kg/year. However, there are only two hospitals equipped with incinerators (e.g., Hanh Phuc Hospital and An Giang Central General Hospital). The remaining hospitals need to negotiate and sign contracts with other environmental companies for HMW collection and treatment. In addition, before HMW is collected and treated, it must be stored following the provisions of the joint circular No. 58/2015/TTLT-BYT-BTNMT on medical waste management. Therefore, the management of HMW at the hospital before collection and treatment is considered one of the most key stages. In Long Xuyen City, HMW emissions are increasing year by year, which will significantly affect the environment, daily life, and health of residents unless proper management and handling, and treatment. Therefore, it is necessary to evaluate the HMW management at the hospitals to understand the current situation and proposed the solution for better HMW management in the city.

This paper describes the current generation, collection, and treatment of all operating hospitals in Long Xuyen City, An Giang Province (Vietnam), including 4 provincial, 3 private, and 13 local hospitals. A general assessment of the status of HMW management will be provided after investigating the actual situation, which forms a basis for proposing solutions to minimize the arising amount and support HMW management in the future. The research results will be the basis and premise for the future management and treatment of HMW in Long Xuyen City, An Giang Province, and across the country.

2. Material and methods

2.1 Research location

Long Xuyen is a large city directly under An Giang Province (Figure 1), which is one of the two largest political, economic, cultural and scientific, and technical centers of the Mekong Delta, Vietnam. Long Xuyen has a natural area of 115.35 km^2 with an average population of about 400,000 people and a population density of 2,450 people/km^2 [10]. Thus it was chosen as a study site in this work.



(a) (b)

Figure 1 Site map of An Giang Province (a) and study area of Long Xuyen City (b)

2.2 Methods of sampling and data analysis

In this study, several research methods were implemented, including surveys, data collections, statistics, and field investigation on the emission situation in some areas generating HCW [11]. The data were then compared to several circulars and current legal documents related to HCW management. The study also consults experts and proposes solutions to manage and handle the HCW problems in the city. By applying the survey forms and designing interviews through questionnaires for the MW management, the stakeholders of this study are the waste management department (Department of Natural Resources and Environment, DONRE), the company that direct collecting, transporting, and treatment of HCW (An Giang Urban Environment Co., Ltd), and the MW generating units in Long Xuyen City (hospitals in different levels and clinics). The data collected through questionnaires, notes, observations, and interviews were analyzed using statistical Excel, which was then displayed in a column and pie charts. the data were then manipulated and changed to percentage scale. Finally, the assessment is made for the current status of collection and storage, transportation, and disposal of HMW.

3. Result & discussion

3. 1 Current status of HMW generation at medical facilities in Long Xuyen city

Currently, Long Xuyen City has 20 hospitals in operation, including 4 hospitals at the provincial level, 3 private hospitals, and 13 local hospitals at the ward/commune level. From the survey, the ratio of OSW and HMW are shown in Figure 2, where HMW is accounted for 21% of the total waste generated. In addition, the amount of HMW generated in those areas is different since the scale of medical examination and treatment and the operation of the hospital are different. In small local hospitals, the number of patients admitted is small, accounting for only 13% of the total number of patients at the hospital (e.g., a total of 2000 patients). Moreover, the activities at these small hospitals are mainly dispensing drugs and injecting vaccines, so the amount of HMW generated is just only about 5 kg/month. In contrast, the amount of HMW generated at the larger hospitals has a significant difference in the volume and type of HMW, ranging from 350-38,000 kg/year, mainly from the activities of vaccination, medical examination, emergency, and treatment for patients in the province. In general, the amount of HMW generated from medical facilities in Long Xuyen City is 7,792,995 kg/month with the highest amount from An Giang Central General Hospital of 3,133.21 kg/month (Table 1). In 2016, the amount of HMW from medical examination and treatment activities of some hospitals in the Long Xuyen City was estimated at 93,515.79 kg/year, accounting for nearly one-fifth of the total estimated HMW in An Giang Province (500,000 kg/year).

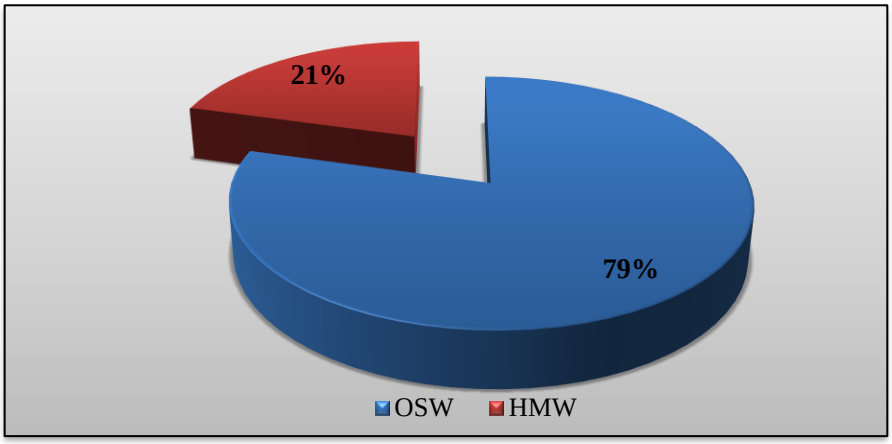


Figure 2 The ratio of OSW and HMW at hospitals in 2016 of Long Xuyen City

Table 1 Estimated weight of HMW at health facilities at hospitals of Long Xuyen City in 2016

STT	Place	HMW (kg/year)
1	An Giang Central General Hospital	37,598.5
2	An Giang Heart Hospital	6,139
3	Vuong Tron Maternity Hospital	349
4	An Giang Eye-Ear, Nose, Throat-Dental and Facial Hospital	2,260.79
5	An Giang Obstetrics and Gynecology Hospital	20,225
6	Binh Dan General Hospital	1,079
7	Hanh Phuc Hospital	25,691
8	My Thoi Local Hospital	50
9	My Thanh Local Hospital	30.5
10	Binh Duc Local Hospital	28
11	My Quy Local Hospital	51
12	My Khanh Local Hospital	14

The HMW composition is divided into infectious (IHW) and non-infectious (n-IHW) hazardous waste. Figures 3 and 4 depict the mass and composition of HMW, in which IHW particularity accounted for 99% of HMW. The IHW includes sharps waste (16,614.6 kg), non-sharps waste (57,591.9 kg), high-risk infectious waste (755 kg), and human tissues (17,724.5 kg) (Figure 4b). The n-IHW accounts for a very small volume of medical examination and treatment activities at hospitals of about 1%. It includes discarded pharmaceuticals (3 kg), discarded chemicals (5.8 kg), and broken medical equipment (0.15 kg) (Figure 4a), and specifically, used fluorescent lamps, ink cartridges, lubricants, wipes, and batteries (820.99 kg).

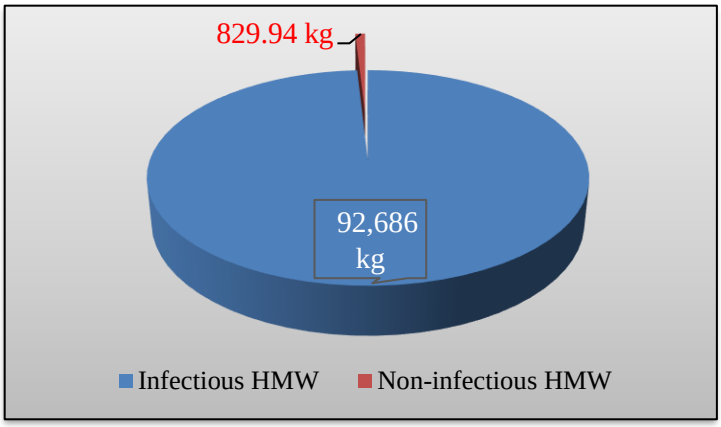
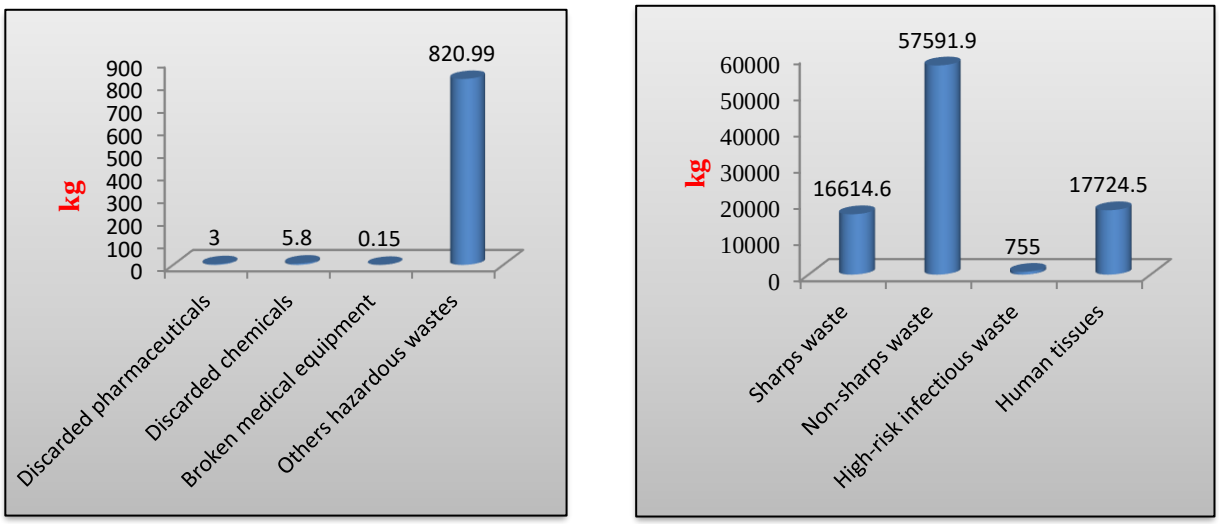


Figure 3 Statistical chart of classification of HMW arising in An Giang province

In the current situation, hospitals all properly collect and classify at source according to Circular 36/2015/TT-BTNMT on hazardous waste management of the Ministry of Natural Resources and Environment (MONRE). All hospitals classified HCW at source into IHW, n-IHW, and OSW and put them in dedicated containers with different colors depending on the type of HCW. Besides, all hospitals had a contract with an environmental company for the collection, treatment, and disposal of HMW or have their own incinerator for burning their HCW.



(a) (b)

Figure 4 Components of n-IHW (a) and IHW (b) in Long Xuyen City, 2016

3. 2 Current status of HMW management in Long Xuyen city

According to Circular 36/2015/TT-BTNMT on hazardous waste management of the MONRE, HMW generated at hospitals are collected and stored by the local unit preserved before being sent for treatment. At the hospitals, the waste managers collect HCW daily and sort it at the time of generation before putting it in the proper containers, which are in a waterproof cement warehouse in an area of at least 4 m^2. Here, the HMW containers are differentiated by different colors and clearly defined with the name for each type of HCW such as yellow for IHW, black for n-IHW, blue for OSW, and white for recycled wastes (Figure 5a). The storage places are built inside the hospital and must comply with the joint circular No. 58/2015/TTLT-BYT-BTNMT with a temperature is 8 ºC for a maximum of 30 days, depending on the type of waste (Figure 5b). Typically, An Giang Heart Hospital strictly obeys the regulations on waste management by MONRE. OSW are collected and stored in green containers, placed around and inside the hospital. After that, the green containers are transported to the gathering area outside the hospital and transported by An Giang Urban Environment Co., Ltd twice a day. For HMW, sharps waste, non-sharps waste, high-risk infectious waste, solid non-infectious waste and liquid non-infectious waste are stored in 1.5 liters yellow containers, yellow bags, 20 liters yellow containers, 120 liters black containers and 5 liters black containers with lids, respectively. Every day, collectors carry them to the 11.5 m^2 HMW warehouse to storing in proper containers. The HMW warehouse is waterproof and clearly labeled. The stored HMW was transported and treated by An Giang Urban Environment Co., Ltd quarterly."

(a) (b)

Figure 5 HCW sorting containers (a) and MW storage (b) at Hanh Phuc hospital, Long Xuyen City

In 2016, HMW in Long Xuyen City was mainly collected and transported by An Giang Urban Environment Co., Ltd, a company that was approved and licensed by the MONRE (Circular No. 36/2015/TT-BTNMT) for HMW collection and treatment. Therefore, the process of collecting and transporting HMW strictly obeys the regulations on HMW by MONRE, and the health of people directly involved in the collection and transportation process is ensured. As of 2016, An Giang has only one hazardous waste treatment plant, invested by An Giang Urban Environment Co., Ltd, located at Binh Duc Landfill, and operated under licensing regulations of the MONRE using an incinerator from Crawford (United State).The solid and liquid hazardous waste incinerator with a capacity of 200 kg/h is programmed to operate with an automatic PLC control system using gaseous fuel (Figure 6). Besides, the exhaust gas treatment system operates synchronously with the incinerator to treating the flue gas generated from the HMW incinerator to ensure QCVN 30:2012/BTNMT, column B. Moreover, the plant is also equipped with a system handling waste used lamps (e.g., fluorescent, compact, and high-pressure) with a capacity of 100 bulbs/h. A stabilizing system for solidification of ash and slag of the incinerator of hazardous wastes and glass chips with a capacity of 2,000 kg/day was also set up for treatment of waste bottom and fly ash. In Long Xuyen City, there are two hospitals equipped with HMW incinerators, including An Giang Central General Hospital and Hanh Phuc Hospital. Hanh Phuc hospital invested in installing a LODY-10 incinerator with 2-stage vertical combustion with an exhaust gas treatment unit with a capacity of 10 kg/h (e.g., 10,722 kg of HMW in 2016) and operating costs of about 3,000,000 - 4,000,000 VND/ton of waste. Recently, An Giang Central General Hospital invested in installing a medical waste incinerator ST-50 with a capacity of 50 kg/h located in the hospital for treatment of their own generated HMW.

The incinerators are commonly used in Vietnam, are designed with the primary combustion chamber for gasification of solid waste, and the secondary combustion chamber for burning out the syngas. The primary combustion chamber is equipped with a primary burner. Diesel oil is supplied to this burner for initial ignition. After that, diesel oil is supplied to the secondary burner until it ignites. The primary burner is then switched off automatically. Atomizing air is provided to the secondary burner for efficient

combustion. A pressure regulating valve is provided on the oil return line to adjust the quantity of oil entering the conversion space. The heat from the primary burner will dry out and start gasification of the solid waste. The transmission area in the primary combustion chamber optimizes the drying and gasification of the solid waste. In the secondary combustion chamber, the sysgas from the primary combustion chamber will burn out. A wall made of ceramic heavy duty refractory lining separates the primary and the secondary combustion chamber. Combustion temperatures at primary chamber and secondary chamber are kept at 800°C and 1200°C, respectively. Therefore, all hazardous and toxic elements can be destroyed effectively [13]. All technical parameters and HMW treatment efficiency of the incinerator comply with National Technical Regulation on Industrial Waste Incinerator (QCVN 30:2012/BTNMT, column B) and National Technical Regulation on Solid Health Care Waste Incinerator (QCVN 02/2012/BTNMT).

Figure 6 Hazardous waste incinerator (capacity of 200 kg/h) at Binh Duc Landfill

Through the survey, there is not any recycling activity for HMW, instead, all HMW were collected, transported, and treated by An Giang Urban Environment Co., Ltd, including 7 medium hospitals and 13 small local hospitals in the Long Xuyen City. The treatment cost is about 100,000 VND/month for each small local hospital. Depending on the contract between the Company and the hospitals, there is a fee for each type of HMW. In addition, some hospitals have collection contracts with other companies that have a license to treat hazardous wastes (e.g., A Chau Environmental Production - Trading - Service Co., Ltd.).

3. 3 General assessment of issues related to HMW in Long Xuyen City

The current situation of generation, collection, and treatment of HCW in Long Xuyen City showed that the management system of HMW in this city has many advantages. The environmental managers construct a good connection between hospitals and authorities in HMW management to meet the requirements and readily help when necessary. The current policy also helps the authorities to timely grasp the current situation of generation, methods of collecting, storing, transporting, and treating HMW in Long Xuyen City. Since then, they can early detect the weaknesses in HMW management of the hospital and quickly provide immediate or long-term solutions to overcome and minimize the impact on the environment and human health. However, there are some disadvantages of the management system. Firstly, hospitals conduct periodic reports quarterly and annually on their HMW

management to the DONRE, but the data in the reports are subjective by the hospital and hard to be validated by the authorities. Also, the monitoring and inspection of the hospital by the authorities on HMW management and environmental quality were conducted every six months. However, it seems to be ineffective because it does not fully reflect the compliance level of the hospitals as well as the emission situation and the level of impact on the environment. Finally, the flue gas quality, the air quality around the treatment facilities, and the solid waste after combustion (bottom and fly ash) have not been strictly controlled and tested [5]. These could inadvertently cause many great impacts on the environment and human health. Although Long Xuyen City has a relatively large amount of HMW emissions as compared to other provinces in the Mekong Delta with no serious environmental pollution recorded, the air environment at and around the HMW treatment site (Hanh Phuc Hospital and Binh Duc landfill) is gradually becoming polluted if the exhaust flue gas treatment process is not properly controlled. Therefore, the environmental agencies need to take measures to monitor, promptly overcome, and strictly handle violations that affect human health and the environment.

3. 4 Proposing solutions to reduce HMW in Long Xuyen city

In general, the HCW management in Long Xuyen City is relatively good. However, when the demand for life is improved with the economic situation, science, and technology development in the future, the health and environmental quality requirements will also be higher. Therefore, some solutions related to HCW reduction in Long Xuyen City have been proposed. The first solution is organizing training sessions for managers, doctors, nurses, and staff to raise awareness of environmental protection at medical examination and treatment places. This could include how to prevent and respond to environmental incidents caused by harmful HMW and how to protect their health when in direct contact with HMW. Second, the collection, storage, transportation, and treatment of HMW must strictly comply with MONRE regulations (36/2015/TT-BTNMT). Next, hospitals with HMW treatment functions must regularly check and periodically maintain equipment and machinery. The current treatment technology also needs to be improved to minimize soil environmental pollution, water and air affect the health of people and the environment. Moreover, a health check for the community living near the HMW emission and treatment area can be done for early detecting diseases caused by HMW and offer solutions in the protection of public health. Furthermore, it is necessary to organize unexpected environmental monitoring visits at the hospital to ensure their regular good practice in HCW management. Additionally, raising public awareness about the influence of HMW and encourage the community to report violations that affect local health and the living environment is important when the online monitoring system is limited. Finally, there should be an appropriate level of encouragement and punishment for hospitals for their HCW management.

4. Conclusion

The management of HMW generated in Long Xuyen City, An Giang Province is done quite well. The generated HMW is segregated at the source, then stored, transported, and treated following the current regulations by the MONRE of Vietnam. However, there is still no strict control of the authorities, especially on the post-treatment control of solid (fly and bottom ash) and

air quality due to exhaust gas after HMW treatment. State policy has some shortcomings in management, which is necessary to strengthen the inspection, unexpected monitoring, and maintenance of specialized treatment systems. For improvement, some possible solutions are suggested, such as adding appropriate penalties for individuals and organizations that violate regulations related to HW management and treatment, paying more on raising community awareness, and checking the health of neighboring citizens to achieve the goal of health and environmental safety.

Conflict of interest

The authors declared that this article has no conflict of interest.

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