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Assessing Solid Waste Management in Can Tho City Central Hospital, Vietnam

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Abstract

Currently, medical waste in hospitals is an environmental issue that is of concern. This study investigates current status of generation and management of solid wastes at Can Tho City Central General Hospital. The results showed that the main composition of solid waste were domestic solid wastes accounting for 80%, hazardous wastes accounting for 16% and recycled wastes occupying 4%. From 2014 to 2018 the total amount of hospital solid wastes decreased by 465 tons. The amount of solid waste generated was not equal between months of the year, the highest in October (108,071 kg) and the lowest in February (54,285 kg). The average amount of solid waste generated per day is around 2,442 kg/day and the average amount of solid waste generated per day per patient bed is approximate 1.9 kg/bed/day. At the hospital, 100% of solid waste generated are sorted and collected. The classification is 100%, the collection and transportation reached 40% compared with the provisions of the Joint Circular No. 58/2015/TTLT-BYT-BTNMT. The hospital leaders need to strengthen solid waste management to ensure environmental sanitation in the hospital.

1.0 Introduction

Currently, environmental protection is a top concern in the world as well as in Vietnam. Social is more developed also means more environmental emissions. Solving these problems is not only required for the management levels of facilities, but also the responsibility of both the political system and the society as a whole. Therefore, in the process of industrialization and modernization the country must pay sufficient attention with environmental protection. Over the past years, along with socio-economic development, people's lives have been increasingly improved, leading to increased demand for medical examination and treatment and health care. Besides, unpredictable changes in climate and polluted environment have caused diseases for human beings. Therefore, the number and size of medical facilities has also increased rapidly to meet the needs of the people for medical examination and treatment and health care. In addition to the positive aspects that health facilities bring, the operation of these facilities also presents risks of environmental pollution from the increasing number of medical wastes and composition complexity. Medical waste is becoming an urgent environmental and social problem in Vietnam. Can Tho is a central city in the Mekong Delta and is a grade I city in Vietnam. With its favorable location and abundant potential, Can Tho city has constantly accelerated socio-economic development, production, service, trade and urbanization in order to improve material life spirit to the people of the area. Therefore, Can Tho city has a significant number of hospitals and medical facilities, along with the increasing amount of medical waste discharged into the environment. Can Tho Central General Hospital is a large

hospital in Can Tho and belongs to the central level [1]. Can Tho Central General Hospital was established on January 12, 2005 on the basis of being separated from General Hospital of Can Tho province under the Department of Health of Can Tho province under Decision No. 22/QD-TTg of the Prime Minister. Can Tho Central General Hospital is a class I hospital under the Ministry of Health, with an area of 61,644 m^2, the scale of 1.250 beds, 45 faculties, 2 centers with 1,300 officials, employees and responsible for health care for people in the Mekong River Delta region. In order to meet the needs of medical examination and treatment and bring patients the best services, the hospital's environmental issue is a matter of concern. The generation of waste at the hospital if not strictly controlled and managed, will affect the surrounding environment and affect the health of the people. The study was conducted to assess the current status of generation and waste management at Can Tho Central General Hospital.

2. Methodology

The information was collected from documents and reports of the hospital in order to understand the current situation, the solid waste management system in the hospital, including: generation source and composition of domestic waste, generation source and solid waste composition from professional activities at the hospital over the years; volume of solid waste generated over the months of the year: hazardous medical waste, recycled waste, domestic waste; average volume of solid waste in a day (kg/day): total volume of solid waste (including general and hazardous waste) generated from all departments/rooms of the hospital; method of classification, collection, transportation, temporary storage and solid waste treatment technology. The information was also collected from documents and reports of the hospital to learn about human resources, medical examination and treatment activities as well as the legal documents system, resources (allocation of funds, human resources) on waste management, equipment and tools in hospital waste management. Direct interview method was used. The interview with the staff in charge of medical waste management at the hospital was performed to collect general information about the hospital: Diagram of the hospital waste management system, organization of management and treatment solid waste and hospital wastewater treatment; Interviewing medical staff and staff of affiliated departments at the hospital: twelve questions were utilized to collect general information about affiliated departments at the hospital: the current situation of waste generation, including the amount of solid waste generated average birth in a day per hospital bed (kg/bed/day) including both conventional and hazardous wastes generated from all faculties, the average amount of wastewater per day per hospital bed (m^3/bed/day) generated from all faculties; the composition of solid waste and wastewater in each department; the hospital's waste management and treatment from the classification, collection and temporary storage, including requirements for waste containers (containers, bags), color codes, icons; location of waste bins in each department; time of collection and frequency of waste collection in a day.

Waste data collected at the hospital were synthesized and analysed by percentage, mean and descriptive statistics using Microsoft Excel software. Comparison of stages in the medical waste management process at hospitals with the Joint Circular No. 58/2015/TLT-BYT-BTNMT of the Ministry of Health and the Ministry of Natural Resources and Environment promulgating regulations on management medical waste to evaluate the implementation of legal regulations on medical waste management at Can Tho Central General Hospital [2].

3. Results and Discussion

3.1 Current situation of solid waste generation in the hospital

3.1.1 Composition of solid waste at the hospital

Infectious wastes: Infectious waste sharp like needles; injecting needles; the sharp end of the transmission line; probe needle; acupuncture needles; scalpel blades; surgical saws and other sharp objects. Non-sharp infectious wastes: absorbent, sticky waste containing blood, biological fluids of

the body; waste generated from isolation disease; gloves after use. Waste with a high risk of infection: samples; instruments for containing, sticking patient samples, and waste attached to patient samples arising from laboratories. Anatomical waste: tissue; human body parts such as organs, internal organs [2].
Toxic wastes: Chemicals; obsolete pharmaceutical products; broken thermometer; other hazardous wastes such as fluorescent lamps; batteries, accumulators [2];
Recyclable wastes: Infusion bottles, line; glass bottles; office paper; paper, pharmaceutical boxes and containers; beverage bottles and cans [2].
Domestic solid wastes: The main composition was organic waste such as leftovers; inert and persistent ingredients such as food packaging, containers; types of paper, cleaning garbage from departments, rooms and some other common wastes. Domestic solid waste accounted for 80% of the solid waste volume of the whole hospital, mainly due to waste from cafeterias and charity cafeterias producing domestic waste. In addition, the turns of people taking care and visiting patients are also relatively large (the numbers of visiting patients were 420,480 people and the inpatients were 57,692 in the year of 2018) , so the amount of domestic solid wastes accounted for a high rate compared to other types of waste. Infectious waste accounted for 16% and recycled waste accounted for 4% of the hospital waste weight. Non-communicable hazardous waste accounted for a very low percentage of the hospital's total waste volume because it is not generated regularly [2].

3.1.2 Amount of solid waste generated at the hospital
Based on Figure 1, the amount of waste tends to decrease from 2014 to 2018, this may be due to the strengthening of the hospital management and waste reduction measures at the source. In addition, awareness of staff, medical staff, patients and patients is also increased.

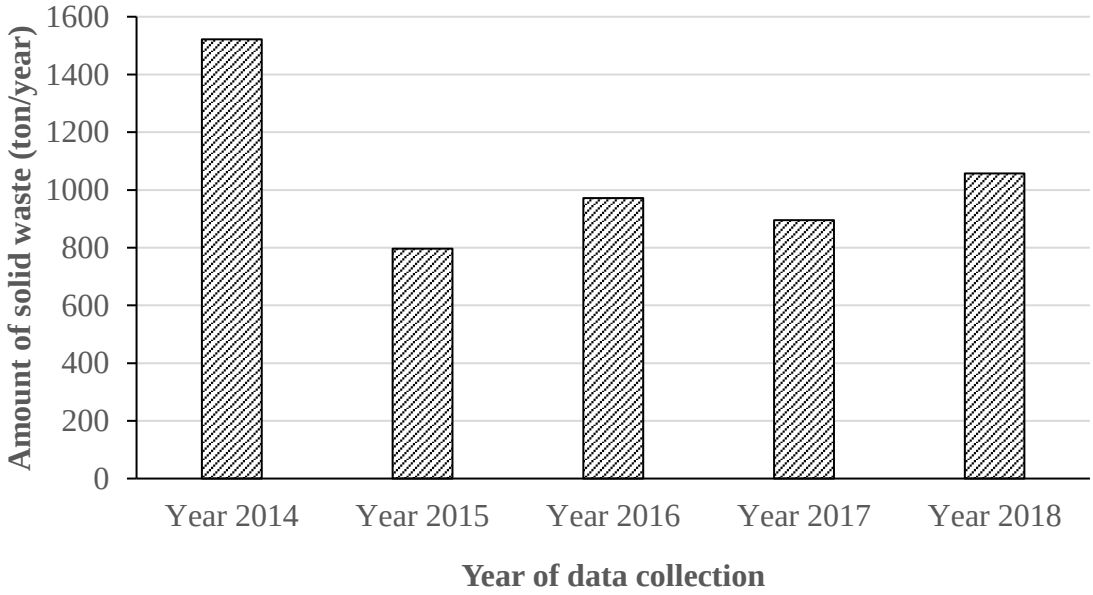

Figure 1. Amount of solid waste generated during 2014 – 2018 [3-6]

Depending on the number of patients receiving medical examination and treatment over the months of the year, the amount of generated solid waste fluctuates, partly due to changing weather and climate conditions, leading to a different amount of waste each month. The variation in solid waste volume over months in 2018 is shown in Figure 2. In 2018, the total amount of solid waste generated was about 1,057 tons/year. It can be seen that February has the lowest amount of waste (54,285 kg) due to the Lunar New Year, so people often avoided medical examination and a large number of patients were released for outpatient treatment. In May, June, July, August, 9, 10, 11, and 12, there was a high amount of waste caused by climate change, seasonal weather which can cause diseases, so the number of patients coming for medical examination and treatment disease also increased.

This led to the amount of generated waste also increased and was highest in October with the volume of (108,071 kg). It can be seen that the amount of waste fluctuates continuously in months of the year.

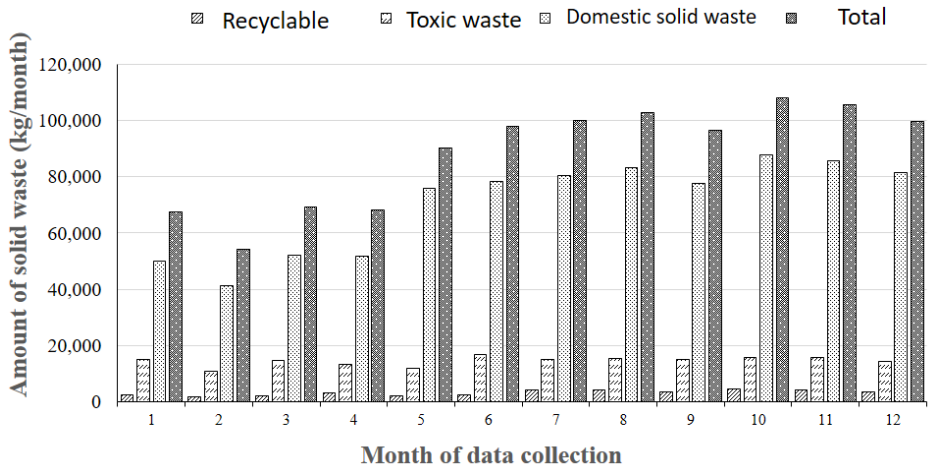

Figure 2. Amount of solid waste generated by month in 2018 [6]

The amount of waste generated in 24 hours based on the 2018 statistics is shown in Table 1. The amount of waste generated daily at the hospital was very large with a total volume of 2,442 kg/day. In 2018, the total number of actual hospital beds of the hospital was 1,278 hospital beds, equivalent to the amount of waste per day estimated at 1.9 kg/bed/day.

Table 1. The amount of solid waste generated in a day in 2018 [6]

No.	Solid waste types	Amount (kg/day)
1	**Infectious wastes**	**456**
	Sharp wastes	20
	Non-sharp wastes	428
	Anatomical wastes	8
2	**Toxic wastes**	**4.6**
	Chemicals	2.25
	Pharmaceuticals	0.43
	Amalgam fillings discarded	0.027
	Others	1.9
3	**Domestic solid wastes**	**1,981**
	Recyclable wastes	81
	Domestic wastes	1,900
Total:		**2,442**

3.2 Current situation of solid waste management in the hospital

3.2.1 Human resources at the hospital

Table 2 showed that there were very few staff involved in waste management at the hospital, only 3 specialized staff for this task while the full-time staff played a very important role in the work of solid waste management (SWM) that they participate in all work in the process of SWM at the hospital. On the other hand, the collection staff only included 4 people who carried out the collection and transportation of the wastes for the whole hospital. With the limited numbers of solid wastes collectors, the wastes were collected imcompletely and not timely. This could result in poor management of SWM in the hospital. Human resources involved in the management of SW at the hospital also has a large number of doctors, physicians, pharmacists, nurses, technicians who will actively participate in the classification of waste at the generated source.

Table 2. Human resources for SWM [1]

No.	Staff	Duty	Number
1	Solid waste management staff	General management	3
2	Nurse	Classification, placement of wastes into the proper waste bins	36
3	Solid waste collectors	Classification, collection, transporation	4

3.2.2 Financial allocation for solid waste management at the hospital

Funding sources for SWM at the hospital include the state budget, hospital fees, other legal sources such as loans and socialization. According to the survey results, the budget for the regular operation of the hospital's SWM in 2018 was 1,541,114,550 VND (excluding the cost for the treatment of solid waste with external units), in which the funds were used to pay for the following items: buying sharp waste bins and containers; purchasing 15-liter, 240-liter waste bins and surgical waste bins; purchasing labor protection tools with the total amount of 1,217,040,000 VND; Electricity fee for the operation of the wastewater treatment system was VND 234,702,300; purchasing chemicals for wastewater treatment including disinfection chlorine, seeds of microorganisms, PA, NaOH with the total amount is 89,372,250 VND [1].

3.2.3 Equipment and tools in solid waste management at the hospital

The survey revealed that all equipment in solid waste management meets the requirements of both quantity and quality. Instruments containing waste generated in hospitals have criteria to meet the requirements under the provisions of Joint Circular No. 58/2015/TTLT-BYT-BTNMT [2] (Table 3).

Table 3. Equipment and tools in solid waste management at the hospital

Equipment	Amount	Equipment	Amount
Bags for toxic wastes	2 types (yellow, black)	Containers for solid wastes 15L (blue)	1.200 pcs
Bags for domestic wastes	2 types (blue, white)	Containers for solid wastes 15L (yello)	350 pcs
Box for containing sharp waste 1.5L	7.200 pcs	Containers for solid wastes 15L (white)	350 pcs
Containers for sharp wastes 6.8L	2.000 pcs	Containers for solid wastes 15L (black)	50 pcs
Containers for solid wastes 240L (blue)	200 pcs	Containers for anatomical wastes	20 pcs
Containers for solid wastes 240L (yello)	100 pcs	Protective clothes	50 pcs
Containers for solid wastes 240L (white)	100 pcs	Protective gloves	100 pcs
Containers for solid wastes 240L (black)	15 pcs	Protective masks	100 pcs

3.3 Current situation of solid waste classification, collection, transportation, storage and treatment in the hospital

3.3.1 Solid waste classification at the hospital

In the hospital, hazardous and ordinary wastes were classified at the place of generation and at the time of generation, hospital wastes were classified as follows:

Infectious wastes were stored in yellow-colored tools and storage equipment, specifically as follows: Sharp infectious waste in yellow puncture-proof bins or boxes; Non-sharp infectious waste in a bag or in a bag with a yellow bag lining; Anatomic waste was stored in 2 bags or in a yellow-

lined pail; Hazardous waste was highly contagious in bags or in a container with a yellow bag lining. Non-contagious hazardous waste was stored in black bags or pockets. Recycled waste was stored in white bag or pail bags. Ordinary waste was stored in blue bag.

Table 4. Evaluating the implementation of legal regulations in solid waste classification

No	Joint Circular No. 58/2015/TTLT-BYT-BTNMT	Evaluated
1	Yellow for packages, tools, and equipment containing infectious waste	Good
2	Black for packaging, tools, and equipment containing non-infectious hazardous waste	Good
3	White for packaging, tools, and equipment storing recycled waste	Good
4	Blue for packaging, tools, and equipment for storing common waste	Good
5	Waste bins and containers have a convenient opening and closing lid during use	Good
6	Sharp waste containers must have a hard bottom without puncture	Good
7	The location of packaging and using medical waste classification must have instructions on how to classify and collect waste	Good

In addition to the regulations on color classification, packages (bags), tools (barrels, boxes), hospital waste storage equipment have attached symbols based on the provisions in Appendix 2 issued together with Joint Circular No. 58/2015/TTLT-BYT-BTNMT. The hospital performed well the sorting of waste, always strengthened supervision for medical staff to classify waste at the source and in accordance with regulations, the amount of waste in bins/bags in departments, rooms was not too full. Waste bins were located at locations with instructions on how to classify and collect wastes according to regulations. However, the classification also faced some difficulties because the majority of patients and their family members still did not know the instructions for waste classification. According to the interview results, there were 83% of medical staff's opinion that the classification of hospital waste was good, the remaining 17% thought that the classification of hospital waste was temporary. This result showed that the waste classification at the hospital was relatively in nature, there was still the situation of misclassifying waste in some waste containers in a few departments and rooms. The hospital needs to regularly closely examine the classification of waste at the source to better classify waste.

3.3.2 Solid waste collection at the hospital

In general, the hospital did a good job of collecting infectious waste, non-communicable hazardous waste, recyclable waste and ordinary waste separately. In clinical departments, the solid waste sorting and collection activities of the departments were equipped with waste containers on medical staff's syringes and waste containers located in the departments of the department. In subclinical departments, waste containers were located in the rooms, right where the waste was generated. There were instructions for sorting and collection at the waste containers.

Through the surveys at the hospital, staff collects waste bags in departments, rooms were tied tightly, waste containers have a tight lid, did not leak waste to the outside. The location of waste containers in faculties and rooms was convenient for sorting and collection. The centralized waste containers were often located in separate areas, especially infectious waste containers in departments were located in separate areas and often utilized the toilets as temporary storage places in the department. On the other hand, in some departments, a centralized container for common waste was placed next to the aisle. Placing a centralized waste container next to the aisle could affect passers-by as the centralized waste container can generate a bad smell if it is not transported by staff to the centralized waste storage facility for a long time of the hospital.

Table 5. Evaluating the implementation of legal regulations in solid waste collection

No.	Joint Circular No. 58/2015/TTLT-BYT-BTNMT	Evaluated
1	Infectious waste, non-contagious hazardous waste, and ordinary wastes must be collected separately from the place of origin to the waste storage area within the medical facility.	Good
2	In the process of collection, waste bags must be sealed, waste containers must have tight lids, ensuring no waste is dropped or leaked during the collection process.	Need to be improved
3	Medical establishments shall prescribe the appropriate route and time of collection of infectious waste.	Need to be improved
4	Wastes with a high risk of infection must be preliminarily treated before being collected to the waste storage and treatment area on the campus of the medical facility.	Need to be improved
5	Frequency of collection of infectious waste from the generated place to the waste storage area in the medical facility campus at least 01 time/day.	Good

The hospital collected waste to the hospital's centralized storage place with a frequency of 2 times a day (5 hours - 6 hours and 15 hours - 16 hours). Every morning at 5 o'clock and in the afternoon at 16 o'clock, cleaning staff and nurse carried out cleaning and garbage collection into bins, then the environmental staff transported waste from departments to the storage. Wastes were collected by staff to the centralized storage of the hospital according to the quantity based on the waste delivery and receipt book in each department and room. Although with the regular frequency of hospital waste collection, but the conventional waste collection container in some departments of the hospital still occurred waste overload, the waste fell onto the floor. According to the results of interviewing medical staff at the hospital, it showed that 67% of the respondents said that the hospital waste collection was good, the remaining 23% said that the waste collection at the hospital was at medium level. Through the actual survey results, waste collection did not completely meet the regulations.

3.3.3 Solid wastes transport at the hospital

The transportation of waste at the hospital consisted of 2 phases including the transportation phase on the hospital premises and the transport phase out of the hospital. Currently, there were no routes to transport waste to a separate storage area within the hospital, but with the aisle of the people, medical staff and through the medical examination, treatment and care in the hospital. In addition, the hospital did not have its own waste transportation elevator, waste was transported by the hospital's general elevators. Through observation, vehicles and tools to transport waste were relatively good, with wheels, handles, thick-walled, undamaged tanks. Waste was transported from the faculties to the concentrated storage area of hospital by pushing a whole container of concentrated waste. However, hospital waste transporters and hospital waste collectors and transporters were not fully equipped with protective equipment. In the process of transporting infectious waste out of the hospital, the staff to collect and transport waste at Can Tho City Tuberculosis and Lung Disease Hospital was not equipped with adequate labor protection equipment. This could have direct harm to the health of the person doing the transport. Although there were specialized tools, in reality, sometimes transporters still used their hands to pick up the bags of waste from one bin to another to fill the bin with the aim to limit the number of transportation of waste out of the clinical departments. In addition, the infectious waste container was too full, unable to cover tightly according to regulations. According to the interview results, there were 83% of medical staff's opinion that the transportation of hospital waste was good, the remaining 17% thought that the transportation of hospital waste still needed to be improved. However, according to the actual survey, the transportation of waste in the hospital was not satisfactory because there was no separate transportation route.

3.3.4 Storage of solid waste at the hospital

Currently the hospital had separate storage areas for infectious waste, recyclable waste and general waste. Because the size of the storage facility was not consistent with the volume of each type of waste generated, the hospital currently leaves these wastes outdoors, on the ground that did not meet the criteria specified in the Joint Circular No. 58/2015/TTLT-BYT-BTNMT [2]. However, the hospital was equipped with tools and materials such as absorbent materials, fire protection equipment to cope with possible incidents such as leaks or spills. Waste was not stored in an approved storage facility. The hospital needed to make roofs for waste storage areas to properly store waste. Through actual surveys, it showed that only the common waste storage area had a cover, the rest storing other types of waste had no roof. The infectious waste storage time at the hospital was not more than 2 days. The hospital's centralized waste storage place was located away from canteen, patient room, public walkways and crowded areas. In addition, the waste storage tools and equipment were in accordance with the correct specifications, such as a bin with hard walls, no cracks, no leakage of waste fluid, with the prescribed logo and lid. Waste storage tools and equipment were also periodically cleaned. According to the survey, although tools and equipment were in compliance with regulations, the waste in some containers was too full and swung on the top of the bin so the lid was not covered. Therefore, the hospital needs to improve the problems.

3.3.5 Solid waste treatment

The hospital did not currently treat hazardous solid waste at the hospital (the incinerator has been shut down since July 2016). All types of solid waste generated in hospitals were contracted to transport and treat with functional units. The hospital signed a contract for the transportation and treatment of hazardous waste with Can Tho City Tuberculosis and Lung Disease Hospital, which included infectious waste and non-communicable hazardous waste. Can Tho City Hospital of Tuberculosis and Lung Disease would collect and transport waste once a day according to the actual amount on the waste delivery record and waste delivery book with the payment method of 1 time/month. At Can Tho City Hospital of Tuberculosis and Lung Disease, waste was treated by wet heat autoclave technology combined with cutting and grinding capacity of 2,240 kg/day. Conventional hospital wastes were contracted to perform with Can Tho Urban Joint Stock Company with a frequency of collection once a day and upon sudden request of the hospital. Recycled waste was collected by Thien Trung Investment and Trading Company Limited at least 3 times/month (on day 5-15-25 monthly) or upon request of the hospital.

4. Conclusion

In general, the surrounding environment of Can Tho Central General Hospital was very clean, with many trees to help regulate the hospital environment. As a central level hospital, the hospital has paid much attention to environmental issues of the hospital. The survey conducted in the hospital has shown that the hospital waste management was implemented according to the regulations of the Ministry of Health and the Ministry of Natural Resources and Environment. The hospital's solid waste composition was mainly domestic solid waste accounting for 80%, followed by hazardous waste with 16% and recycled waste accounted for 4%. Wastes tended to decrease over the years, with differences over months of the year. From 2014 to 2018 the total amount of hospital solid waste decreased by 465 tons. The average amount of solid waste generated in the hospital per day was about 2,442 kg/day and the average amount of solid waste generated in a day per hospital bed was about 1.9 kg/bed/day. The hospital has classified solid waste according to color codes as prescribed in the Joint Circular No. 58/2015/TTLT-BYT-BTNMT. In the hospital, 100% of solid waste generated were sorted and collected. Classification was 100%, collection and transport worked 40% compared with regulations in Joint Circular No. 58/2015/TTLT-BYT-BTNMT.

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