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Medical Waste and Its Management at Wangaya Hospital in Denpasar

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Abstract

Medical waste has three forms; solid, liquid and gas which derives from hospital activities which contain microorganism, chemical material, and radioactive substances. Based on the description above, this research was necessary to be conducted to handle the negative impact of medical waste on the environment. The research objectives were 1) in order to know the medical waste management system of Wangaya Hospital in Denpasar, and 2) studying more about the medical waste quality of Wangaya Hospital in Denpasar. The research was a case study in using a method that was designed by combining the observation data with the laboratory data analyses. The research location was in Denpasar of Wangaya Hospital (B type) regarding on the high occupancy rate of the patient as compared to another hospital (B type) in Bali. The research results were to show that 1) the medical waste management of Wangaya Hospital in Denpasar was suitable yet to meet the procedure of medical waste from Decree of Minister of health No.1204 in 2004, regarding Health Condition of Environmental Hospital. The laboratory results show that the medical waste quality in Denpasar Wangaya Hospital was above the maximum of standard limit based on Decree of Minister No. 58/MENLH/12/2004. The ashes of incinerated medical waste contained a Hg heavy metal until 2,39 ppm. Based on the research results it was concluded that the management system of medical waste in Denpasar Wangaya Hospital was suitable yet with the procedure, and the medical waste quality of outputs that was released into the environment still exceeding the maximum standard limit. Therefore, it is recommended that Denpasar Wangaya Hospital should undertake the evaluation in the management system of the medical waste and its treatment plan to reduce the effluent in its output products in order to comply with the standard limit.

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1. Introduction

Waste material is stated as medical waste that has been solid or liquid derived from the hospital activities at containing pathogenic microorganisms, chemicals toxic and radioactive materials. The medical waste volume is not as much as domestic waste, however, it has a greater negative impact on the environment and human health. Adiputra (2003), Yong *et al.*, (2009), Huffman (1996), medical waste becomes more need attention, as compared to other waste for medical waste, consists of pieces of human bodies, the blood waste, body fluids, infusion bottles, antibiotics residual, drug waste, needles used, radioactive fluids and discharges laboratories, as well as expired medicines, was. In order to look at the composition of the medical waste, it is classified into hazardous and toxic waste (B3).

The research was conducted in several countries unlike Portugal, USA, Singapore, and Canada generally incinerators use is shown for medical waste treatment turned out to cause new problems. The new issue is occurred of air pollution by smoke and dust combustion products. Smoke and dust are produced by combustion that contains high levels of heavy metals that come mission into air e.g.: Cd, Pb, Cr, Mn, As, Hg and Ni. The smoke and dust consist of dioxins and furans. Dioxin is a carcinogenic substance that able to influence the reproductive system and lowered immune function. Heavy metals Hg is known neurotoxin. Their greatest influence on children health under five that causes of death (Adiputra, 2004).

The poor medical waste management in Indonesia hospitals are reflected by survey results to the World Health Organization (WHO) and the Ministry of Health in 1997. The survey was conducted on 88 hospitals in the outskirts of Jakarta. Based on WHO criteria, the hospital waste management said that be good when the percentage of medical waste 15% of the total waste generated hospitals, while in Indonesia the percentage reached 23.3%. The survey also found that separate hospital waste is only 80.7%, 20.5% simply do lug, transporting only 72.7%. Anwar *et al.*, (1996), Arisandi (2002), Hadi *et al.*, (2005), the survey results as well as to show that the waste management infectious waste incinerator about 62%, 51.1% of toxic waste and radioactive waste in the International Atomic Energy Agency (Batan) 37%. In relating of the issue to how the management and medical waste supervision in hospitals, B type generally are found in the city district, one of them is Regional General Hospital (Hospital) Wangaya Denpasar.

Wangaya Hospital is categorized B type that located in Denpasar downtown almost every day many patients treated here. The average occupancy rate of patients annually in Wangaya Denpasar hospitals about 138.249 patients. In 2002, the patients who were in Wangaya hospital about 134.459 peoples and in 2003 the patients were about 142.004 patients. Logically, the more patients in one hospital, therefore, the higher the volume of medical waste generated. The high medical waste volume will influence the effectiveness level of medical waste management that is conducted by the hospital. DepKes (2003), Hendrawan (2005), Wangaya Denpasar Hospital has had IPAL and incinerator for medical waste preventive, in accordance with the processing terms of medical waste in hospitals B type. However, incinerators Wangaya Denpasar hospital does not function optimally, due to the blower and burner (automatic fire sprinkler) do not work properly. In one hand, burning process that has done by the incinerator does not reach optimal temperature about 900 ^{0}C to 1200 ^{0}C. in another hand, Wangaya Denpasar Hospital never measures the medical waste volume generated, either solid or liquid waste. Drs & BA (2003), Hassan *et al.*, (2008), Wangaya Denpasar Hospital merely rarely monitoring the waste quality generated. Monitoring the medical waste quality unlike microbiological is done four times a year. Monitoring the medical waste quality is chemically done once a year and emissions from the incinerator are never done. Gordon (1942), Jang *et al.*, (2006), it is better to improve the quality service towards medical waste to keep the green life of surrounding environment, especially the health of people living around the hospital and the patients who are in Wangaya hospital. In order to know the negative impact on medical waste and medical waste management in view Wangaya Denpasar Hospital, this research is needed to be done.

2. Research Methods

Materials and Methods

This research is a case study, wherein, is designed by combining the two data, those are observations field data and laboratory test result data. The data are taken and as well as divided into two types i.e. before and after processing. The research location is conducted at Wangaya Denpasar Hospital, particularly, in the medical waste processing take place. The laboratory test is conducted in Analytical Laboratory of Udayana University Jimbaran, Bali Regional Laboratory

and *Balai Hiperkes* Denpasar. This research was conducted for seven months from December 2004 to June 2005, next to collect the data was done for two months from March to April 2005.

The data that is obtained from field observations and laboratory test results must first be tested its normality and homogeneity if the results are normal and homogeneous. If it a vice versa, therefore, it will be tested with non-parametric statistics. Non-parametric statistics test is a test that the model does not have specific requirements regarding population parameters which are central research samples, while, parametric statistical tests is a test that the model establishes the specific conditions of the population parameter is a source of research samples (Siegel, 1990).

Gsianturi (2003), Idat (2003), the descriptive analysis is applied in this study. It is done to show a description of waste quality comparison that produced by Wangaya Denpasar Hospital, before and after processing. As well as it used to in the evaluation process of medical waste management at Wangaya Denpasar hospital for monitoring guidelines based on the Ministry of Health No. 1204 in 2004 about Regulation of Hospital Healthy Environment and regulations that relate with B3 waste management (Harahap, 2010; Indonesia, 2009).

3. Results and Analysis

The patients reached 11,000 persons and the surgery patient's number of 150 surgeries per month, Hospital Wangaya average per day produce a plastic bin of 15 solid medical waste, the weight average is about 4 kg. At this time, Wangaya hospital Denpasar never keep records of the amount of medical waste generated among per-day, per month or per year. The results of the number of field recording medical waste hospital Wangaya in March and April are shown in Table 1.

Table 1
Total of a solid medical waste of Wangaya Hospital on March to April

Week	Month	
	March	April
I	218 Kg	225 Kg
II	180 Kg	215 Kg
III	172 Kg	227 Kg
IV	210 Kg	245 Kg
V	255 Kg	-
The waste that was taken for recycling	51 Kg	55 Kg
Total of waste	1086 Kg	967 Kg
The average waste from March to April	1026,5 Kg	

In terms of sewage treatment, Wangaya Denpasar hospital performs treatment with solid medical waste incinerators and wastewater treatment to the Waste Water Treatment Plant (WWTP). Incinerator special qualifications for processing medical waste incinerator with an average length of time the combustion takes up to 2 hours for one combustion. In addition, Wangaya Hospital as well as received a solid medical waste incineration services from polyclinics and health centers in Denpasar. Delivery of solid waste from polyclinics and health centers in Denpasar that it is usually done on an average one to two times a month, with the average amount of solid medical waste received up to 62 kg.

Kusminarno (1989), Suhendrayatna (2001), Reinhardt (2018), Pratiwi (2013), Nainggolan (1998), Subagiarta (2004), medical waste management in hospitals type B has at least its treatment incinerator for solid medical waste and wastewater for it. Medical waste management system depends on whether the waste in solid or liquid form. According to Decree No. 1204 of the Minister of Health in 2004 on the Requirements of Environmental Health Hospital, then there is a very important of medical waste management has phases, namely the separation or segregation, lug, collection, transportation, and combustion.

a) Segregation or separation and lug.

Marinković *et al.*, (2008), Putri (2010), medical waste separation id did by each room. The separation occurs imperfectly. Regarding the Health Minister Decree No. 1204 in 2004 about Hospital Healthy Environment Regulation, medical waste has been separated Wangaya Denpasar hospital, it can be said that is not in accordance with the procedure. Medical waste separation should as well as being conducted in accordance with the characteristics of medical waste that is infectious, highly infectious, pathological, pharmaceutical chemical waste,

cytotoxic and radioactive waste. In term of serving a medical waste bin or lug, it should also provide medical waste in each treatment room. Medical and non-medical waste provision shelter in each treatment room is available to avoid its waste disposal mixing. In terms of material made of medical waste in Wangaya Denpasar hospital is not meet the requirements, due to it merely uses ordinary plastic bucket lined red plastic bag. The shelter medical waste is essentially required to meet the requirements to use criteria such containers have made of strong, light enough rust-resistant, water-resistant and has a smooth surface inside.

b) The collection of solid medical waste

The collection of medical waste should be completely separated between medical and non-medical, based on the characteristics of the medical waste. The collection of medical and non-medical waste that are combined to be one in Wangaya Denpasar Hospital will lead to contamination of non-medical waste by medical waste. Although, the medical waste has been wrapped in plastic bags, however, the plastic bags leakage will increase the risk of contamination. It is from the separated room that is the first step to minimize contamination of non-medical waste by medical waste. The separation process should as well as be followed by a separation step at the time of collection, for medical waste, collection timing must also be collected in a safe place and out of reach of people who are not interested. Unlike, the collection of medical waste in Wangaya Denpasar hospital wherein medical waste is collected together with the non-medical waste and untreated sterilization of medical waste. In conclusion, the collection of medical waste in Wangaya Denpasar hospital has not been done in accordance with the procedure.

c) The medical waste transportation

Moersidik *et al.*, (2015), PPM &PL (2003), Wisnu (2001), the medical waste transport is required to use a special trolley, therefore, medical waste is classified into B3 type waste. It is done by garbage carts in Wangaya Denpasar hospital would have deviated from the medical waste transport procedures. The medical and nonmedical waste transport in a wheelie bin as it happens in Wangaya Denpasar hospital will enlarge the contamination of non-medical waste towards medical waste. In order to collect the waste directly by hand, it will increase the likelihood of occupational accidents, unlike the one infection due to scratching syringe. So that, the medical waste transport in Wangaya Denpasar hospital is not in accordance with Ministry of Health Decree No. 1204 of 2004 respecting the Hospital Healthy Environment Regulation.

d) The storage of solid medical waste

Slamet (2000), Siegel *et al.*, (1997), Soekidjo (2003), Wijanto (2005), solid medical waste should be stored in a place that is safe and closed. The storage of medical waste is not able to be entered by people who are not inconvenienced. It is put out place unlike laid out in front of the building incinerators will increase the likelihood of contamination in the environment. It must comply with a tropical climate that is the longest rainy season and the dry season 46 hours in 24 hours latest. Pollution worse will happen when the waste up to three days, especially during the dry season. Therefore, the storage process of medical waste in Wangaya Denpasar hospital has not done perfectly, in terms of both storage security and storage times.

e) The burning of medical waste

Although, the burning of medical waste in Wangaya Denpasar hospital is done in incinerators, however, it is a conventional combustion. It can be said as a conventional combustion due to combustion is done manually, so that occurs malfunction of the burner (automatic sparking), and the diesel is used as fuel. The process increasingly is imperfect combustion process to malfunctioning blower (referring to chimney smoke), therefore, the burning smoke out through the door incinerator is not closed and some gaps cavity incinerator. The incinerator chimney that the height is merely a meter worsens the condition. This situation will certainly lead to ambient air pollution. According to Sukendar (2005), Wisaksono (2001), Wibowo & Olszewski (2005), medical waste incineration process effectively is done at 1600 ^{0}C temperature specifically for metal medical waste in 600 ^{0}C – 1200 ^{0}C temperature towards non-metallic medical waste. In conventional combustion at Wangaya Denpasar hospital, it is conducted at 200 ^{0}C temperature. The burning of medical waste there is as well as said to be effective for weight yet the ash reached 29.06 to 36.11% of the medical waste weight of burning. The heavy metals content is high due to chemical and metal elements in the medical waste is not burned completely so that, there is no sublimation. The burning of medical waste is produced by dioxins substances cause of plastic waste is burned in medical waste. It shows that the burning of medical waste in an incinerator of Wangaya Denpasar Hospital with the conventional combustion method has not been effective.

f) Disposal of ash

The medical waste ashes in Wangaya Denpasar hospital has been discharged directly throw at Sungai Badung (Badung River), it has been violated procedures that contained waste management of working on that. The ash based waste management working procedures should be stockpiled in a certain place. The hoarding can be done

when the ashes of medical waste have undergone treatment. Disposal of medical waste incineration ash from the border to the Sungai Badung may cause water pollution being. The heavy metals in ash will also affect towards water quality of the river. Bali Provincial Health Office should together BAPEDALDA Bali and Denpasar government conduct surveillance and monitoring of the wastewater quality is discharged into natural Denpasar Wangaya Hospital. They should also impose sanctions on Wangaya Hospital Denpasar disposing of medical waste incineration ash from the border to the Sungai Badung.

The ash was tested in the ambient air quality of 3 points observations show the highest ash content in the room incinerator that reaches 111.12 µg/m^3, and the lowest ash content was in hospital environment i.e. 55.56 µg/ m^3. The air pressure differences between the inside of incinerator room and big hall of incinerator building, therefore, the dust fall faster to incinerator room to incinerator inside, so that the amount of dust in the air from the room is reduced incinerator building. The influence of speed and wind direction also lead a dust in the hospital environment less is. The dust content in the settlement (110.13 µg/m^3) to be higher than in a hospital due to the dust comes mastering from, vehicle, environment societies, and incinerator.

Results of testing of NO_2 level in the medical waste combustion Wangaya Denpasar hospital is obtained that the lowest of the NO_2 level is towards settlements (20.827 µg/m^3) and the highest is in a hospital environment (25.919 µg/m^3). The low level of NO_2 of settlements areas than it is occurred in the incinerator room due to the measurement is quite far from NO2 source is a short distance by incinerators and highways. NO_2 content in the hospital environment is higher than in the incinerator room for NO_2; it happened on deriving from the incinerator, the exhaust from vehicles and smokestacks kitchen.

The results of the lab are obtained that CO gas level in incinerator room about 1422.23 µg/m^3 and CO_2 about 528528, 50 µg/m^3. On testing in 3 points, it is obtained that CO content in the highest settlements (1848.89 µg/m^3) and the lowest in incinerator room is (1422.23 µg/m^3). This situation is occurred by CO gas of social activities, in addition to the contribution of hospital incinerator, gas content of CO in the settlement as well as CO gas pollution from vehicles.

The results of the quality test at three observation are obtained the lowest CO2 content of the gas is in a residential area about (264,264.26 µg/m^3), this occurs because the monitoring location far enough away from sources of the CO2 gas producer. CO2 content is greater in the hospital environment (1,585,585.60 µg/m^3) than in the incinerator room (528,528.50 µg/m^3) as a source of CO_2 in hospital incinerator environment and smoke of motor vehicles.

Based on ambient air quality testing at three points was observed that the highest Pb contents were in the room incinerator (0.734 ug/m3). This condition occurs because the sampling is quite close to the source of pollution, especially burning by using the help of diesel fuel. The content of Pb in the settlements is higher than the hospital environment as a source of Pb in the settlement waste sourced from the fumes, hospital incinerator, incinerators, and other people's activities.

Results of laboratory tests on the ashes of medical waste in Wangaya Denpasar hospital visible content of heavy metal elements is quite high when compared to Quality Standard effluent B3 waste in accordance with the Decree by Head of Environmental Impact Management Kep-04/Bapedal/09/1995. *As* is heavy metal contents is high enough in the medical waste ashes that reached 1,820 ppm. It has been exceeded the quality standard limits. The results of laboratory tests on the medical waste ashes in Wangaya Denpasar hospital is obtained that Cr content reached 76,42 ppm. If it is compared towards a decree, the content of Cr in the ashes of medical waste in Wangaya Denpasar hospital has exceeded the quality standards. The content of Pb in the medical waste ashes that place reached 8.357 ppm. In respecting of Kep-04 / BAPEDAL / 09/1995 Pb metal content of 0.1 ppm maximum is tolerated. This means that the Pb metal content in the ashes of medical waste on that place is not in accordance with the quality standards set. Laboratory Test Results in combustion ash of medical waste Wangaya Denpasar hospital showed Mn metal content reached 101.28 ppm. Based on the reference Mn metal content in the wastewater for B3 waste processing activities in accordance Kep-04/Bapedal/09/1995 the maximum tolerated 2 ppm. Lab test results against Hg in the medical waste in hospitals Wangaya Denpasar obtained Hg content reaches 2.39 ppm. Hg maximum content allowed in wastewater at B3 waste processing activities in accordance Kep-04/Bapedal/09/1995 is 0.002 ppm. The content of Ni in the ashes of its medical waste reached 32.67 ppm. The content of Ni is allowed for B3 wastewater processing activities in accordance with a decree that is 0.2 ppm. This means that the content of Ni in the ashes of medical waste in Wangaya Denpasar hospital does not meet the quality standards requirements.

Table 2
The comparison of heavy metal content towards ash by medical waste burning with wastewater standard for B3 waste management

No	Parameter	Unit	Lab test result	wastewater standard for B3 waste management in accordance with Kep-04/Bapedal/09/1995
1.	As	ppm	1,820	0,1
2.	Cd	ppm	5,689	0,05
3.	Cr	ppm	76,42	0,5
4.	Pb	ppm	8,357	0,1
5.	Mn	ppm	101,28	2
6.	Hg	ppm	2,39	0,002
7.	Ni	ppm	32,67	0,2

In managing, the liquid medical waste with wastewater management systems, the medical waste liquid is generated from each room should no longer be accommodated in septic tanks. Therefore, the wastewater treatment system using wastewater must go through various stages of processing, it cannot be done with a single process unlike in Wangaya Denpasar hospital that merely makes the aeration alone process. Wastewater treatment process is not perfect will take effect the environmental quality wherein the waste is disposed of. The results of temperature measurements in the field (*in situ*) is obtained that the liquid medical waste temperature after processing IPAL reached about 34^0 C. The high temperature occurs because of medical waste liquid is in a tank that size is quite narrow (3 cm x 2 cm x 3 cm). The temperature rise is also caused by a medical waste liquid tank that accommodated on getting sunlight directly. The quality test results of liquid medical waste in Wangaya Denpasar hospital average of pH of the liquid medical waste after processing wastewater reaches 8.39. This value is well within the maximum specified. BOD5 measurement results on the liquid medical waste after processing at the IPAL reached an average of 9.38 mg/l. This value is in accordance with the standard provisions. In regarding Kep-58/MENLH/12/1995 the maximum limits BOD5 content is tolerated in 30 mg/l. in accordance with laboratory analysis is to show that the average COD content in liquid medical waste samples after processing reached 27, 85 mg/l. Generally, the content COD to its liquid medical waste after wastewater treatment is higher than its BOD_5 content. This is to show that some organic materials are difficult to chemically decomposed can be oxidized well. The COD value in the medical waste was still in accordance with the quality standards. The results showed that dissolved solids in the liquid medical waste after processing at the IPAL reached an average of 22.5 mg/l. In respecting to the decree 58/MENLH/12/1995, the maximum number is tolerated of 30 mg/l. It means that TSS concentration in the liquid medical waste in accordance with quality standards. The measurements results on liquid medical waste showed the NH_3 content of liquid medical waste after processing at the IPAL reached an average of 0.25 mg/l. In regarding Kep-58/MENLH/12/1995 NH_3 content of the tolerable maximum of 0.1 mg/l. That means the NH3 content in the medical waste of Wangaya Denpasar does hospital not meet the standard quality. Based on the measurement of phosphorus content towards liquid medical waste after processing at the IPAL reached an average of 0.75 mg/l. In accordance with a decree that is, content tolerated up to 2 mg/l. This condition means that the liquid medical waste in terms of phosphate content compliance with quality standards and worthy to be released into nature. The test results in the laboratory showed that the bacterial content *fecal coli* (E. coli) is negative in liquid medical waste samples. E. coli consists of negative bacterial in the after IPAL processing for liquid waste that goes into the tank IPAL merely by the kitchen and *laundry*. The test results for *coliform* bacteria in the liquid medical waste generated coliform bacteria content in both samples is still below the quality standards established. *Coliform* bacteria in the liquid medical waste on average is higher than *faecal coli* bacteria. In term of this indicates the observation sample contains more matter that is organic. The organic material of medical waste sample in according to the author's project from food scraps and waste material coming from the kitchen are eventually deposited on the IPAL tank.

Table 3
The test of waste medical liquid quality microbiologically that is conducted in Wangaya Denpasar Hospital

No	Parameter	Wastewater *Inlet*	Wastewater *Outlet*
The test of waste quality microbiologically on November 23, 2003			
	E. Coli	0	0
	Coliform	0	0
The test of waste quality microbiologically on March 1, 2005			
	E. Coli	8	5
	Coliform	2400 MPN/100 ml	17 MPN/100 ml

4. Conclusion

a) The procedure is to manage medical waste management in Wangaya Denpasar hospital does not meet standard requirements by Ministry of Health Decree No. 1204 in 2004 on Prerequisites of Environmental Health Hospital. There are several factors indicative unmet medical waste management, namely: the medical waste separation that has not been perfect, non-labeling or distinction color of shelters waste, the transport that does not use the special *trolley*, medical waste burning does not occur at the optimum temperature and execution of processing ash combustion products before discharging into the environment.
b) The processing waste quality in Wangaya Denpasar Hospital does not meet standard quality limits that established under Decree of Environment Minister No. 58/MENLH/12/1995 about Liquid Waste Quality Standard for Hospital Activities. In regard the ashes of medical waste containing heavy metals is still high enough.

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