THE EFFECTS OF HOSPITAL EFFLUENT DISCHARGES ON THE QUALITY OF WATER

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ABSTRACT

Wastewater which comes from the hospital is very dangerous for the environment if the hazardous waste is disposed to the river without a proper treatment. The current research will investigate the common pollutant that is generated from the hospital wastewater such as BOD, COD, TSS, Phosphorus, Ammonia, total pH, Microbacterial, and some of the heavy metals such as Zn, Cu, and Fe. And, it is compared with the National Water Quality Index of Malaysia and Environmental Quality Act (EQA) 1974 for the allowable range of healthy water in current river which is connected with hospital sewerage system. The experimental method is used to take the concentration of each element and the result is very significant because the concentration from the hospital sewerage system is very high such as 16.84 mg/L BOD, 60.67 mg/L COD, TSS is 0.01 mg, 6 mg/L NH_3 –N, 3.22 mg/L PO_4^{3-}. Except the result for Microbacterial and pH which is 10.67 CFU and ^{pH} is 6.43. And heavy metals concentration such as Fe, Cu and Zn is very satisfied which is Fe is 0.02 mg/L, Cu is 1.03 mg/L and Zn is 0.20 mg/L. All the result is compared to the National Water Quality Index of Malaysia and Environmental Quality Act 1974.

Keyword:

Experimental Method, Hospital Wastewater, Heavy metals, Urban Sewerage system, River, Total Coliform

INTRODUCTION

Water is the important thing for the life of the surrounding species such as Animal and Plant. It can support their need during the metabolism process. But, water can be a disposal place also which contain some contaminants which dangerous for the human being (Ojo et.al, 2012). Water which contains some contaminants or a pollutant can be generated from the activities near surrounding such as Residential Place, Hospital, Factory and Agriculture. Each of the wastewater have some characteristic and it can affect the surrounding environment especially hospital wastewater. Because the waster contain some dangerous material from each of activities in the hospital like clean the equipment after surgery, clean the floor, water from clinical laboratory and etc. (Amirhossein & Bahareh, 2016)

Some hospital can give a serious damage to the environment if the pollutant such as Pharmaceutical, Heavy metals and Microbacterial cannot be treated properly. These are the common pollutant which the most hospital generates especially in Hospital Pantai Ampang (Al-ajlouni, et. al 2009; Kumarathilaka, et al. 2015). The common Pharmaceutical contaminant like BOD, COD, ph, Total Suspended Solid, Ammonia and Phosphorus. The salmonella and E.coli is classified as the Microbacterial contaminants and the common Heavy Metals which appears in the hospital wastewater are Zinc (Zn), Ferrous (Iron), and Copper (Cu). The flow of water that flows before the hospital is very smooth and there are no obstacles at all to the water conditions that are very turbid and dirty because it is contaminated with residential activities that occur around the area. But the pollutants that affect only a little compared to pollutants produced after the hospital. Hence, the aim of the study is to determine the pollutant

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LITERATURE REVIEW

The characteristic of the hospital wastewater has a similarity with other wastewater from other place. Hospital need more water with the average of ranging from 400 to 1200 L/day/bed. Then, the average amount of the wastewater generates with the hospital activities is ranging from 362 to 745 L/day/bed. There are a few parameters which are considered as the criterion of good quality of the water. Those parameters are Physiochemical, Metal and heavy metal and Microbiological. The physiochemical elements consist of BOD and COD, Total Suspended Solid (TSS), Ph, Ammonia, Chlorine, phosphate, while the heavy metal elements consist of Zinc, Copper (Co), Fe and The Microbiological element consists of total coliform to investigate the total amount of the bacteria contaminate in the wastewater of the hospital. (Akin, 2016; Meo et. al, 2014; Kusuma et. al, 2013).

Some contaminants has been investigated by the researchers. Some of the contaminant in hospital wastewater is a common contaminant that has been generated by other places also but the amount of the contaminant is higher than other places. There are a lots of activities that can make some pollutant is higher and it can disturb the ecosystem. They can make growth of wild algae is very high and it can make the amount of the oxygen is low. And it can make the fish died. Others, it can disturb the food chain of the organism also. But, all the hospital have a pretreatment that can make the contaminant treated properly so that the dangerous material cannot make some issues for the river water (Emmanuel et. al, 2002; (Mesdaghinia et.al, 2009).

Some of the country have their standard guideline for the water quality index that can be a main safety purposes for the water. It can show the range of the safety and healthy water for the living things in the surrounding environment. In Malaysia, they used NWQS (National Water Quality Standard) for Malaysia and EQA 1974 (Environmental Quality Act) 1974 for Industrial waste. But the investigation of the hospital wastewater is very rare in Malaysia. Malaysia have a lots of sophisticated hospital and their hospital is well-known. It is very necessary to make the investigation for the hospital wastewater because Malaysia is developed country.

Hence, the prevention of the contaminants of the wastewater is very important to keep the environment healthy and safe for all living things in surrounding of environment. It can keep the sustainable ecosystem to make the living things is prosperous afterwards.

Table 1: Classification and status of water quality based on WQI calculation (Department of Environment Malaysia 2004)

WQI (CLASS)	CATEGORY	CLASSIFICATION IN TERMS OF WATER USAGE
0-25 (V)	Very bad	Extensive treatment is required Irrigation
26-50 (IV)	Bad	Recreational use with body contact
51-70 (III)	Medium	Water supply – conventional treatment required
71-90 (II)	Good	Conservation of natural environment. Water supply – practically no treatment necessary except disinfection or boiling
91-100 (I)	Excellent	

Table 2: National Water Quality Standard (NWQS) in Malaysia
And the definition for each class (Harun et. al, 2015)

*Parameter	Unit	Class					
		I	IIA	IIB	III	IV	V
pH		6.5-8.5	6.5-9.0	6.5-8.5	5.0-9.0	5.0-9.0	-
DO	mg/L	7	5-7	5-7	3-5	< 3	< 1
Temperature	ºC	-	Normal + 2ºC	-	Normal + 2ºC	-	-
TDS	mg/L	500	1000	-	-	4000	-
Conductivity	µS/cm	1000	1000	-	-	6000	-
Salinity	%	0.5	1	-	-	2	-
SS	mg/L	25	50	50	150	300	300
AN	mg/L	0.1	0.3	0.3	0.9	2.7	> 2.7
BOD	mg/L	1	3	3	6	12	> 12
COD	mg/L	10	25	25	50	100	> 100

Table 3: Environmental Quality Act (EQA) 1974
Source: Lakasa Environment Quality Act (EQA) 1974

Parameter Limits Of Effluent Of Standards A and B

No	Parameter	Unit	Standard A	Standard B
I.	Temperature	°C	40	40
II.	pH Value	--	6.0-9.0	5.5-9.0
III.	BOD_5 at 20°C	mg/l	20	50
IV.	COD	mg/l	50	100
V.	Suspended Solids	mg/l	50	100
VI.	Mercury	mg/l	0.005	0.05
VII.	Cadmium	mg/l	0.01	0.02
VIII.	Chromium, Hexavalent	mg/l	0.05	0.05
IX.	Arsenic	mg/l	0.05	0.10
X.	Cyanide	mg/l	0.05	0.10
XI.	Lead	mg/l	0.10	0.50
XII.	Chromium, Trivalent	mg/l	0.20	1.00
XIII.	Copper	mg/l	0.20	1.00
XIV.	Manganese	mg/l	0.20	1.00
XV.	Nickel	mg/l	0.20	1.00
XVI.	Tin	mg/l	0.20	1.00
XVII.	Zinc	mg/l	1.00	1.00
XVIII.	Boron	mg/l	1.00	4.00
XIX.	Iron (Fe)	mg/l	1.00	5.00
XX.	Phenol	mg/l	0.001	1.00
XXI.	Free Chlorine	mg/l	1.00	2.00
XXII.	Sulphide	mg/l	0.50	0.50
XXIII.	Oil and Grease	mg/l	Not Detectable	10.00

METHODOLOGY

Some experiment has been conducted to perform the data and analysis the effect of the hospital wastewater for the river. The location of the hospital is in Pantai Hospital Ampang and then it is located between the residential house and urban city. There are 3 points of the data taken which is located on the urban drainage and the hospital sewerage is connected with it and the final disposal is going to the river. The other points is located after and before the sewerage system and it can make the good comparison of the water which is affected by after drainage of the hospital that is connected with the urban sewerage system. The water sample is taken with the amount of the bottle is 5 litres of the bottle for each point. And then the water sample is going to the lab to be tested. The result will be performed by the Excel to show the data about the experiment result for each parameter such as BOD, COD, TSS, Ph, Ammonia, Phosphorus, Microbiological and Heavy Metals like Fe, Zn and Cu.

RESULT AND DISCUSSION

BOD and COD

From the data obtained during the experiment, the concentration of the BOD is within the range for point 1 and point 3. And, for the second point that is located in the drainage is very high because the water is contaminated from the hospital sewerage system. The sewerage system of hospital is connected to the sub part of the urban sewage system and the final disposal is connected to the river. Point 1 is showing the result 1.44 mg/L BOD, point 2 has the result 16.84 mg/L BOD, and the last point has the result 1.01 mg/L BOD. And the amount COD in the wastewater from hospital is very high. Point 1 is showing the result 73.33 mg/L COD, Point 2 is showing the result 60.67 mg/L COD and Point 3 is showing result 20 mg/L COD. Those result can be affected by the others activities in the surrounding environment. The disposal of waste from surrounding urban area can increase the amount contaminant in the water. The result of BOD and COD show that the point 3 is lesser than the point 1 even it is affected by the second point from the sewerage system which is connected with hospital drainage. Because at 1 point there are disposal activities from the residential area and make concentration of contaminant increase respectively.

The presence of BOD in current of wastewater is low for the point 1 and point 3 even it is affected by the BOD from the drainage or point 2 which has a higher concentration from other point. The hospital is treated properly for the BOD so that it can be decomposed with the water after the discharge. The efficiency of the BOD treatment is affected by the pretreatment plant that the hospital provided. It can treat the 31 % of the BOD while the overall efficiency of the wastewater treatment is 58 % percent (Kusuma et al., 2013). In Iran the total of the BOD treated is very good which has a significant of the result which has a 67.5 % and 64.3 % of the pretreatment plant that has been used for the treatment plant (Majlesi et al,. 2008). So the research shows that the efficiency of the current hospital treatment is good to treat the BOD and it is near to the present study. The concentration of the COD in current wastewater show a good result even it is affected by the second point which is high. The contaminant can be decomposed naturally after the flow is passing through the discharge. It can be shown with the effective of hospital pretreatment to treat the COD as the harmful contaminant. The other study shows that the current treatment of the hospital have the similar efficiency with the other treatment plant to treat COD. It has 84 % efficiency of the hospital pretreatment plant to make the treatment properly (Prayitno et al,. 2017).

Table 4: Test result of Biological Oxygen Demand Chemical Oxygen Demand.

	BOD1		BOD5	
POINT	SAMPLE	mg/L	SAMPLE	mg/L
1	1	7.42	1	7.92
	2	7.45	2	7.8
	3	7.43	3	7.88
	Average	7.43		7.87
Total BOD		**1.44**		
	BOD1		BOD5	
POINT	SAMPLE	mg/L	SAMPLE	mg/L
2	1	8.43	1	3.74
	2	8.43	2	3.02
	3	8.46	3	3.4
	Average	8.44		3.39
Total BOD		**16.84**		
	BOD1		BOD5	
POINT	SAMPLE	mg/L	SAMPLE	mg/L
3	1	8.22	1	7.42
	2	7.63	2	7.44
	3	7.6	3	7.68
	Average	7.82		7.51
Total BOD		**1.01**		

	COD	
POINT	SAMPLE	mg/L
1	1	69
	2	55
	3	96
	Average	**73.33**
	COD	
POINT	SAMPLE	mg/L
2	1	67
	2	66
	3	49
	Average	**60.67**
	COD	
POINT	SAMPLE	mg/L
3	1	36
	2	12
	3	12
	Average	**20.00**

PH and TSS

The concentration of PH, Total Suspended Solid, Ammonia, Phosphorus and Microbacterial is very significant. Total Ph at point 1 is 6.71, Point 2 is 6.43 and Point 3 is 6.87. For the Total Suspended Solid at Point 1 is 0.02 mg, Point 2 is 0.01 mg and Point 3 is 0.01 mg. The amount of the pH can determine the condition of the water. The performance of the hospital to keep the range of the pH can be shown with the good result in some studies. The mean pH value of raw wastewater of all studied hospitals was 7.5. In a study on Turkey hospitals, the mean pH of raw wastewater hospitals was 7.3 (Altin et al., 2003). In another study on hospitals wastewater, somewhere in the globe, the mean pH value in health-care centers wastewater was about 7.2. According to the standards of IREPA, the acceptable level of PH to discharge of effluent to receiving water is 6.5 to 8.5 (IR EPA, 2003), considering our study findings it is clear that pH of studied hospital wastewater were compatible with this standards using NWQS (National Water Quality Standard). For the total suspended solid the performance of the pretreatment plant of the current hospital is very good. All studied that has been conducted in Iran with some hospital shows the good efficiency of the total suspended solid pretreatment for the current hospital. It shows the result of between 66 % until 87.9 %. The range of performance efficiency of the current treatment is near to the result.

Table 5: Test result of Total Suspended Solid (TSS) and Ph

	TSS				
POINT	SAMPLE			before	after
1	1	0.01		0.11	0.1
	2	0.02		0.11	0.090
	3	0.02		0.11	0.090
	Average	**0.02**			
	TSS				
POINT	SAMPLE			before	after
2	1	0.02		0.11	0.090
	2	0.00		0.11	0.11
	3	0.00		0.11	0.11
	Average	**0.01**			
	TSS				
POINT	SAMPLE			before	after
3	1	0.02		0.11	0.090
	2	0.01		0.11	0.1
	3	0.01		0.11	0.1
	Average	**0.01**			

	PH	
POINT	SAMPLE	
1	1	6.70
	2	6.71
	3	6.72
	Average	**6.71**
	PH	
POINT	SAMPLE	
2	1	6.42
	2	6.43
	3	6.43
	Average	**6.43**
	PH	
POINT	SAMPLE	
3	1	6.86
	2	6.87
	3	6.89
	Average	**6.87**
with 60 ml of Water		

AMMONIA, PHOSPHORUS, MICROBACTERIAL TOTAL COLIFORM

The concentration of the Ammonia at Point 1 is 4.58 mg/L NH_3 -N, Point 2 is 6 mg/L NH_3 -N and Point 3 is 5.22 mg/L NH_3 -N. Phosphorus at Point 1 is 1.65 mg/L PO_4^{3-}, Point 2 is 3.22 mg/L PO_4^{3-} and Point 3 is 1.75 mg/L PO_4^{3}. And total Microbacterial in the water for Point 1 is 33.67 CFU, Point 2 is 10.67 CFU, and Point 3 is 61 CFU. The presence of Ammonia of the current hospital wastewater is higher if it is compared to National Water Quality Standard (NWQS) for Malaysia. The other study shows that the phosphorus is the micro pollutant also which is very difficult to be treated. It must have a good treatment plant which can treat properly. The range of the ammonia is shown up with the range of 1.5 mg/L to 100 mg/L (Geissen et al., 2015; Kumarathilaka et al., 2015). And the maximum range of the current hospital is 3.55 mg/L but it is still high compare to the guideline. The pretreatment still need some development for the better quality of the water. And the presence of Phosphorus of the current hospital wastewater is higher if it is compared to National Water Quality Standard (NWQS) for Malaysia. The other study shows that the phosphorus is the micro pollutant also which is very difficult to be treated. It must have a good treatment plant which can treat properly. The range of the ammonia is shown up with the range of 1.5 mg/L to 100 mg/L (Geissen et al., 2015; Kumarathilaka et al., 2015). And the maximum range of the current hospital is 3.55 mg/L but it is still high compare to the guideline. The pretreatment still need some development for the better quality of the water. The result determine the amount of E.coli and Salmonela which is contains in the current wastewater. Since, the total amount of dangerous bacteria is less than the 1000 CFU/100 ml water sample so it can be a good condition for the water itself. The amount of the

Microbacteria for another study shows a good value for the safe water. The performance of the water treatment plant is 99.74 % and 99.36 % respectively (Beyene et al,. 2011). In Iran, the study about treatment plant for the microbacterial using the appropriate treatment plant shows the better result also. The pretreatment plant can reduce the microbacterial 95 % (Amirhossein et al,. 2016; Amouei et al., 2012). For the present study, the result is very near which the microbacterial is treated properly and the amount is within the safety water quality index.

Table 6: Test result Phosphorus, Ammonia and Microbacterial

	PHOSPHORUS	
POINT	SAMPLE	mg/L
1	1	1.76
	2	1.83
	3	1.37
	Average	1.65
	PHOSPHORUS	
POINT	SAMPLE	mg/L
2	1	3.98
	2	3.43
	3	3.23
	Average	3.55
	PHOSPHORUS	
POINT	SAMPLE	mg/L
3	1	1.76
	2	1.83
	3	1.67
	Average	1.75

	AMMONIA	
POINT	SAMPLE	mg/L
1	1	4.54
	2	4.58
	3	4.62
	Average	4.58
	AMMONIA	
POINT	SAMPLE	mg/L
2	1	6
	2	6
	3	6
	Average	6.00
	AMMONIA	
POINT	SAMPLE	mg/L
3	1	5.22
	2	5.2
	3	5.23
	Average	5.22

	MICROBACTERIAL	
POINT	SAMPLE	CFU
1	1	32
	2	22
	3	47
	Average	33.67
	MICROBACTERIAL	
POINT	SAMPLE	CFU
2	1	10
	2	0
	3	22
	Average	10.67
	MICROBACTERIAL	
POINT	SAMPLE	CFU
3	1	124
	2	30
	3	29
	Average	61.00

HEAVY METAL

The common heavy metals which contain in the hospital wastewater are Fe, Cu, and Zn. The range of each heavy metals is within the range according to the EQA 1974 for industrial. The safe water must have maximum value of Fe is 4 mg/L, Cu is 1.0 mg/L and Zn is 2.0 mg/L. The total concentration of Fe is 1.03 mg/L, Cu is 0.2 mg/L and Zn is 0.02 mg/L.

Presence of the heavy metal in the hospital wastewater can determine the quality of treatment plant which is used for the current waste. The study show that heavy metal is dangerous material with all the characteristic problem to make some diseases. The result shows that the heavy metal for the hospital wastewater is within the range. Even for some hospital in the other country with a lot of hospital which is provided with the variety of the pretreatment plant, the presence of the heavy metal is lower compare to their current wastewater quality standard (Akin, 2016; Amirhossein et al, 2016; Kümmerer, 2009). The current hospital treatment plant performance is very good to the heavy metals such as Fe, Cu, and Zn. It is near to the other researcher which is used particular water treatment plant.

Table 7: Test result of Heavy Metals

	Zn	
POINT	SAMPLE	mg/L
2	1	0.02
	2	0.02
	3	0.02
	Average	**0.02**
	Fe	
POINT	SAMPLE	mg/L
2	1	0.75
	2	0.67
	3	1.67
	Average	**1.03**
	Cu	
POINT	SAMPLE	mg/L
2	1	0.24
	2	0.13
	3	0.22
	Average	**0.20**

CONCLUSION

Wastewater is one of environmental issue that can damage the aquatic environment. It can break the food chain in the aquatic environment and it can endanger the ecosystem. So, treatment plant is very important to make the water healthy for all living things in surrounding area. There are a lots of type of the wastewater such as factory, storm water, hospital wastewater and etc. Hospital wastewater is very dangerous also. Because it contains harmful material that can make imbalance in surrounding environment.

The experimental work show the significant result of effect hospital wastewater and all the activities in surrounding area. The parameter of BOD, COD, and pH, Ammonia, Phosphorus, Microbacterial, Zn, Cu and Fe is the common parameter for hospital wastewater and the result is higher compare to the National Water Quality Standard (NWQS) for Malaysia. River water should be in Class IIA for the allowable range but most of the result shows within class VI and above. So, the water needs more treatment to make it healthy and it is safe for all species in neighborhood. From the data obtained some of the result for each contaminant is high in point 2 because of the activities of the hospital and surrounding. But the hospital contribute 50 % of the wastewater which came out from the drainage.

Therefore, the amount of the contaminants is out from the standard that has been determined. And the effect of the hospital wastewater will increase some contaminant such as Ammonia and Phosphorus in the river water. And heavy metal is within the range for safe and healthy water. The pretreatment of the hospital can treat some of the contaminant and they can decomposed well in the water so that they cannot disturb the ecosystem. But, the other contaminant is very small and it is called micro contaminant which cannot be treated properly by the treatment.

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