CHARACTERISTICS OF EFFLUENT WASTEWATER IN HOSPITAL (IN LITERATURE REVIEW)

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ABSTRACT

Background: Waste from medical and non-medical activities can be generated by hospital health service operations in both solid and liquid forms. Hospital liquid waste is waste that endangers the environmental ecosystem and human health around the hospital and even the wider environment. The purpose of this study was to determine the value of wastewater effluent after treatment which includes BOD, COD, TSS in wastewater from various hospitals.

Method: This study is a literature review study. Searching for articles using the published or perish application is continued, followed by database searches on Scopus, Google Scholar, Semantic Scholar, published in 2018-2023. 69 articles found were then selected into 5 articles.

Results and Discussion: based on the 5 reviewed research articles it was found that the average values for the chemical parameters of hospital wastewater from various hospitals in several countries showed that the BOD, COD, TSS parameters exceeded waste disposal standards, besides that other hazardous substances were detected, including the use of other disinfectants used in large quantities in health care facilities, a significant level of pollution was shown from the surgical section which was almost two to four times higher than other sections, this caused high chemical contamination contained in hospital wastewater.

Conclusion: the characteristics of hospital wastewater show different values between countries. This depends on the type of material, origin of various wastes, region, frequency of detection and quantification of these compounds. Therefore.

Keywords: Characteristics, Wastewater, Hospitals
INTRODUCTION

Hospital liquid waste is waste that endangers the environmental ecosystem and human health around the hospital and even the wider environment. The main objective of wastewater treatment is to protect the aquatic environment and stop the spread of diseases spread by wastewater by reducing BOD, dissolving particles, removing nutrients, toxic compounds, and killing pathogenic bacteria. (Timpua, 2019).

Waste from medical and non-medical activities can be generated by hospital health service operations in both solid and liquid form. Infectious waste from medical activities such as infusion fluids, pathogen and microbiology tests in polyclinics, and isolation rooms is included in hospital wastewater, while bathroom, kitchen and garden wastewater are examples of non-medical wastewater and wastewater containing chemicals originating from medical, laboratory, sterilization, research. (Busyairi et al., 2016).

Along with the progress of medical services in recent times, the volume of hospital wastewater generated has increased. The main source of pollutant discharges into the environment comes from various hospital activities, including surgery, drug treatment, radiology, laundry, operating theaters, chemical biology laboratories and others. (Amouei et al., 2015). Along with the increasing public demand for health services, the number of hospitals continues to grow from year to year. As a result, because hospital waste is included in the category of infectious waste or B3 waste (Toxic and Hazardous Materials), the amount of waste generated by hospital operations will also increase. The Advanced Oxidation Process (AOP) is one technology that has been used to address this problem. The Third European Conference on the Application of Environmental Advanced Oxidation Processes was held October 28-30, 2013, in Almeira, Spain, and marked the third international conference on AOP technology. (Kusuma, Laila, Darmadi, 2017).

The many types of drugs used to treat patients are the main source of chemical and biological contaminants in wastewater discharged from hospitals. Such discharges can lead to serious degradation of several environmental components, especially water and soil, and can pose hygienic risks to human health. The study was conducted at the Hassani Abdelkader hospital in Sidi Bel-Abbes, Algeria. Compared to WHO standards of 90 mgO2/L, 30 mgO2/L, 0.5 mg/l, 1 mg/l, and 1 mg/l respectively, the results show a large amount of chemical pollution COD 879 mgO2/L, BOD5 850 mgO2/L, NH4+: 47.9 mg/l, NO2: 4.2 mg/l, and NO3: 56.8 mg/l. However, since the ratio of COD to BOD5 is absent, this waste is biodegradable. (Benouis et al., 2018).

Several previous studies on wastewater treatment have been carried out in an effort to reduce negative impacts on the environment. (Benouis et al., 2017).

Waste from medical and non-medical activities can be generated by hospital health services in both solid and liquid form. Infectious waste from medical activities such as intravenous fluids, pathogen and microbiology tests in polyclinics, and isolation rooms, while bathroom, kitchen and garden waste water are examples of non-medical waste water. Medical, laboratory, sterilization and research facilities can generate wastewater containing chemicals. (Busyairi et al., 2016).

Hospital wastewater contains physical, chemical and biological characteristics of wastewater which are a source of environmental pollution. As a result, the wastewater discharged into the river must be processed using a wastewater treatment plant (WWTP) which includes processing units in the form of filters, enumerators, sand infiltration ponds, oil and grease infiltration ponds, equalization ponds, then through the
process of settling and flotation carried out at the initial stage,(Fachruddin Azwari et al., 2023).

The purpose of this study was to determine the value of wastewater effluent after treatment which includes BOD, COD, TSS in wastewater from various hospitals.

MATERIALS AND METHODS

This research is a literature review research with a research data base used to search literature through selection based on hospital wastewater criteria, effluent. Next, using a literature review related to the characteristics of hospital wastewater, search using the publish or perish application, then search the Scopus indexed database, Google Scholar, Semantic scholar. The search for research articles relevant to the topic of this research was carried out using the keywords hospital wastewater, characteristics. The journals taken are journals published in 2018-2023. There were 69 journal articles found and then selected based on title and abstract information to see whether the articles met the author's inclusion criteria to be used as literature in a literature review, 5 journals were analyzed. The essence taken from the research is the research title, researcher's name, year of publication, place of research, sample, method, research results with their significance value.

RESULTS

Characteristics of Effluent Wastewater in Hospitals of Babol University of Medical Sciences, Babol, Iran,(Amouei et al., 2015). The results showed that the average value for each parameter was BOD 173 mg/L, COD 231 mg/L, TSS 132 mg/L. The qualitative indicators found in the wastewater of this hospital exceed the standards of waste disposal of the Iranian Environmental Protection Agency (IEPA). The hospital's wastewater treatment facilities often treat wastewater improperly, and the toxic waste discharged into the Babol Rood River and Caspian Sea can pose risks to public health, the environment and animals.

Another study is about the analysis of parameters of pH, BOD, TSS, Oil and Fat and Total Coliform in Liquid Waste at the Gateway Sehat Long Bagun Mahakam Ulu Hospital,(Fachruddin Azwari et al., 2023). The results of the analysis of liquid waste in this study were compared with the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. 68 of 2016, namely with a maximum quality standard of 30 mg/l for BOD and TSS, 5 mg/l. The results of other studies regarding hospital effects management chemical, physical, microbiological risks and legislation in different countries (Carraro et al., 2016). The results of this study indicate that from 12 countries the average TSS value as a physico-chemical indicator for hospital wastewater is 196.4 mg/L, BOD is 218 mg/L. For other hazardous substances, WHO states that healthcare facilities account for up to 5% of mercury released into water bodies through untreated wastewater, and in the UK, more than 50% of total mercury emissions come from mercury contained in dental amalgam and laboratory and medical equipment.

Other hazardous substances that may be present in hospital wastewater are disinfectants, such as chlorine, quaternary ammonium and metal ions. Other disinfectants used in large quantities in health-care facilities are formaldehyde-based (formalin)-based disinfectants for dialyzers and the disinfection of dialysis equipment and associated reverse osmosis units, as well as in pathology. This compound is toxic to fish and other aquatic organisms even at low concentrations.

Pre-design of a Waled regional general hospital wastewater treatment plant,(Anjana, 2021). The results of this study for the effluent from the processing of BOD parameters were 28.35 mg/l, COD 24.14 mg/l, TSS 6.46 mg/l. The
processing stages include the equalization process to disinfection capable of reducing BOD parameters from 675 mg/l to 2.835 mg/l, COD from 1183 mg/l to 8.06 mg/l, TSS from 211 mg/l to 4.305 mg/l, and oil/fat from 125 mg/l to 6.25 mg/l. The next research is about Medical Wastewater Characterization in the Gaza Strip: Al-Shifa Medical Complex as a Case Study. (Al-Najar et al., 2018).

The quality of household wastewater was obtained, namely the BOD parameter of 110 to 350 mg/L, with a significant pollution level (17.18), BOD measured from several departments showed strong contamination. The BOD from the surgical department was 1150 mg/L, almost twice as high as the BOD from other departments. Nephrology/dialysis had the next highest BOD, which was 744 mg/L, while the COD value was 4 times higher than the BOD value, the sources came from blood banks, operating rooms, maternal and delivery clinics, and operating rooms, respectively, COD values were 5350, 2665, 2646, and 2093 mg/L. According to Palestinian Environmental Quality Affaires (PEQA), where BOD and COD cannot exceed 600 and 1500 mg/L respectively, COD from the Al-Shifa complex department is categorized as a strong non-biodegradable substance that requires treatment before being discharged into public sewer systems. Samples from internal medicine, oncology clinics, surgery, and nephrology/dialysis units had very high COD values of 29870, 14080, 3370 and 2167 mg/L, respectively, when evaluated for COD during the cleaning process.

TSS, BOD, COD levels in Iranian hospitals show that hospital wastewater has the same characteristics as household wastewater but some hospitals are forced to choose separate wastewater treatment on site due to significant pollution.

The findings from the Turkish hospital show that the wastewater from this facility can be categorized as domestic residential wastewater of medium strength. Wastewater from three hospitals in Malang in Indonesia has BOD and COD values of 240 and 350 mg/L, respectively (20). Within three months of monitoring, wastewater from three major hospitals in Sri Lanka had maximum verification values for TSS, BOD and COD of 314, 1950 and 1183 mg/L, respectively.

Based on extensive research from France, Turkey, India, Iran, Italy, Thailand, Canada and Greece, Verlicchi et al. compared the qualitative characteristics of hospital and urban wastewater and found that BOD, COD, and TSS were 200, 500, and 160 mg/L for hospital wastewater and 90, 170, and 60 mg/L for urban wastewater, respectively. The BOD, COD, and SS of hospital wastewater are still two to three times greater than those of urban wastewater when these three parameters are considered, together with their average concentrations in urban wastewater.

DISCUSSION

Based on a literature review of 5 articles that examine the characteristics of hospital wastewater in several countries, it can be described theoretically, namely from the first article the total amount of wastewater discharged into the Babol Rood River and the Caspian Sea will be more than 177,175 m3/year if taking into account the estimated amount of wastewater produced by these hospitals (177,175 m3/year) as well as wastewater generated by other locations such as private hospitals, clinics, industry, and residences. However, the hospital generates 192,840 kg of biological organic waste annually, which is discharged into natural resources such as rivers and seas. One of the largest cities in Mazandaran province, Babol, its natural resources will be harmed by this level of pollution as well as other harmful substances emitted by other pollutants. Besides that,
The results of the analysis show that the BOD content in wastewater treated from WWTP is 11.68 mg/L, which meets the quality requirements of less than the maximum allowed limit of 30 mg/L. This indicates that the crushing process has taken place in the control tub while the pre-treatment process has been operating as well as possible. The average removal effectiveness at WWTP using a biofilter system with a BOD value can reach 67.29% (Pitriani et al., 2022).

Another study that examined the TSS parameter on wastewater quality using the gravimetric analysis method found that the TSS value obtained from laboratory test results was 10 mg/L, indicating that the result was below the upper limit of the quality standard of 30 mg/L. This figure shows that the WWTP system in the pre-treatment laundry process at Pratama Gerbang Sehat Hospital has operated efficiently (Goni Preisi, Isri R. Mangka, 2021), claims that the IPAL Unit is equipped with a clarification/sediment tank which, if functioning properly, will reduce TSS.

Monitoring of the wastewater system must cover two aspects, namely monitoring the sewage system and monitoring the quality of the effluent. These include the most common parameters for monitoring effluent quality (temperature, pH, BOD5, COD, nitrate, total phosphorus, total suspended solids, presence and concentration of E. coli). In addition, if the onsite treatment plant is operating, the wastewater inflow and outflow from the treated effluent should be monitored regularly to monitor how efficiently the treatment plant is reducing contaminant concentrations (Carraro et al., 2016).

Regulations, evaluation guidelines and selection criteria for the quality of hospital effluent and their management differ in each member country of the European Union. Disinfectants including chlorine, quaternary ammonium, and metal ions are just a few of the potentially hazardous compounds that can be found in hospital wastewater. Dialysis equipment, associated reverse osmosis units, histology, and formaldehyde-based (formalin) disinfectants are other disinfectants used extensively in treatment room management. Low amounts of this chemical are harmful to fish and other aquatic life. Monitoring of sewage systems and monitoring of effluent quality should be included in the monitoring of wastewater systems. Temperature, pH, BOD5, COD, nitrate, total phosphorus, total suspended particles, and the presence and amount of E. coli, are some of the most frequently observed criteria for assessing effluent quality. In addition, wastewater inflow and outflow from the treated effluent should be monitored if the on-site treatment plant is in operation. When the environment from adverse effects, the development and fate of antibiotics must be considered. The presence of antibiotics in wastewater can even cause changes in the microbial community structure and even develop bacterial genetic resistance (Fardian, E., 2022).

Hospital wastewater also poses a biological problem due to the potential presence of infectious pathogens. In general, wastewater may contain various pathogenic microorganisms (bacteria, protozoa, worms, and viruses) which mainly originate from infected human feces and are primarily transmitted via the faecal-oral route (enteric microorganisms), as well as secondary through the disposal of body fluids, usually in small amounts. The Clean Water Act (CWA), passed by the Environmental Protection Agency (EPA) in the United States in 1972, sets effluent standards for companies that discharge directly into state waters as well as companies that discharge into municipal WWTPs. This standard outlines the characteristics of hospital wastewater that must be present for disposal in surface waters using...
currently available best practice control technologies.

Directive n. 98 European Union of 19 November 2008 (EU, 2008/98/EC) on the Management of Hazardous Wastes and the List of Hazardous Wastes According to European Decree No. 532 of 3 May 2000 (EU, 2000/532/CEE), some hospital wastewater (pharmaceutical products, drugs, residues of materials used as solvents, soaps, organic matter without halogens, etc.) must not be discharged into sewers but must be treated as waste and collected and disposed of accordingly. The EU member states each have their own legislation, standards for HWW management and evaluation for effluent from hospital sewers.

In another study, hospital wastewater was classified as infectious organic wastewater, which had relatively high BOD, COD and TSS characteristics, pH ranged from 6.5 to 7.5, was turbid, contained fatty oils and detergents, and often contained floating particles such as bandages, cotton and sanitary napkins. It also has a relatively neutral composition and contains fatty oils and detergents. If biological treatment techniques, especially anaerobic and aerobic, which are cheaper and simpler to operate and maintain, are implemented, treatment solutions for these wastewater features will be effective and affordable. (Anjana, 2021)

The BOD value was reduced from 675 mg/l to 2.835 mg/l, COD from 1183 mg/l to 8.06 mg/l, and TSS from 211 mg/l to 4.305 mg/l by the RSUD Wastewater Treatment Plant. When developing technology that can be used as a test design to be applied in the field to control the characteristics of wastewater before it is discharged into the environment, parties involved in treatment design can use the results of pre-designed wastewater treatment plants as input.

CONCLUSIONS AND SUGGESTIONS

The results of a review of previous research on the characteristics of hospital wastewater can be concluded that the characteristics of hospital wastewater show different values between countries, the lack of criteria determined by the government is the cause of the high value of chemical parameters which can have a negative impact on human health and the environment. Although most of the major industrialized countries have their own management techniques for treating these effluents, none has yet imposed limits on effluent media containing certain pharmaceutical residues prior to release into wastewater treatment plants or surface waters.

This depends on the type of material, origin of various wastes, region, frequency of detection and quantification of these compounds. Therefore, each country should monitor its own hospital activities from the perspective of public health, water and environmental protection, and potential reuse of wastewater and it is very important to recognize the risks associated with public health promotion from a hygienic point of view.

SUGGESTIONS

Through this research review, further research can be carried out regarding the characteristics of hospital wastewater and its impact on human health, through testing wastewater samples at the WWTP inlet and outlet so that the effectiveness of WWTP work at hospitals in Indonesia can be known in particular.

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CONFLICT OF INTEREST

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LITERATURE


Preisi Goni, Isri R. Mangangka, OBAS (2021). Evaluation of the Performance of the Wastewater Treatment Plant (WWTP) at the Central General Hospital Prof. Dr. RD Kandou