Assessment of Wastewater Characteristics of Treatment Units in some Hospitals in the City of Basra

Assessment of Wastewater Characteristics of Treatment Units in some Hospitals in the City of Basra

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Abstract. This paper presents the results of the flowing water characteristics from the sanitation system studied in targeted hospitals in the city of Basra, Iraq, in four sites from the 1st of December 2021 to the 1 st of March 2022, including two major sites for government hospitals and two main sites for private hospitals. Statistical analysis of a set of physicochemical water quality parameters of flowing water collected directly from hospitals and water flowing before mixing with public sewage was conducted to investigate the efficiency of a hospital wastewater treatment plant in Basra, Iraq. The study concluded that the operational capacity in the selected treatment stations is commensurate with the hospital's absorptive capacity and that all stations from different global origins operate as efficiently. The efficiency of removing Al–Saadi Hospital is 44.7% higher than other hospitals (Al –sader teaching, Al Mawanee, and Al–Mawadda) the efficiency of removing was (43.06%, 41.35%, 37.73%) respectively that have been studied. It is necessary to provide government and private hospitals with biological treatment stations to achieve the water environment in a city that suffers from severe pollution of water resources.

Keywords. Wastewater assessment, Hospitals, Basra.

1. Introduction

Hospital wastewater contains pathogenic agents and hazardous compounds, which pose many risks to different communities' environmental and human health. Healthcare waste is becoming a global public health concern, particularly in developing countries [1].

Wastewater discharged by hospitals is highly toxic compared to domestic sewage because it contains antibiotics, sterilizers, tissues, types of viruses and bacteria, and sometimes radionuclides. Water during consumption and its quality characteristics are radically affected, and many countries do not have strict regulations regarding the disposal of hospital waste, which contains pathogens, toxic chemicals, and radioactive isotopes [2]. It also contains pharmaceuticals, pathogens, chemical reagents, and other harmful substances. Some hazardous substances in hospital wastewater may have a regulatory status that needs to be treated accordingly, while other substances have characteristics similar to domestic wastewater. The global level of hazardous waste types for hospitals, their main determinants , and the characteristics, quantity, and wastewater treatment methods differ between countries and may differ within the same country [1].

The hazardous nature of hospital wastewater, related mainly to its high pharmaceutical load and the presence of pathogenic microorganisms, would require its specific management and treatment. On-site

treatments to reduce the pollutants load and to warrant the effluent disinfection are usually considered the most promising approach in dealing with large hospitals. Applying a highly active technology at a small scale can be more cost-effective and environmentally friendly than a cheaper technology at a large scale with limited effects on diluted hospital discharges [3]. The World Health Organization (WHO) indicates that 80% of the total waste generated from healthcare activities is general waste that includes household waste, while 20% is considered hazardous materials that may be radioactive or toxic [4] Hospital waste is an important source of live material and antibiotic-resistant bacteria in the environment[5].

Sanitation of liquid waste is one of the large health institutions with a large capacity (main hospitals in cities), one of the most important sources of pollution that threatens the environment suitable for individuals and biodiversity. The population's dependence on surface water near the sewage facilities of hospitals complicates the issue of untreated waste control, especially in countries that lack proper management in dealing with liquid medical waste. The efficiency of its treatment of elements and compounds determines their effects on the nearby aquatic environment and the extent of their risks to water quality. Diagnosing the real defect in the management of liquid medical waste by health institutions facilitates the necessity of urging decision-makers towards real measures to develop wastewater treatment processes and stimulates the imposition of strict institutional standards to dispose of liquid medical waste in a healthy and environmentally friendly manner.

The resulting environmental pollution of the liquid wastes from hospitals and various healthcare centers places great pressure on water systems' health. Medical wastewater mixed with pathological factors has a direct catastrophic effect on the environment if discharged directly into rivers without treatment or in cases where it exceeds the specified removal standards. Some of it may not be covered by treatment, and thus contain a large variety of microorganisms, and the organic and inorganic compounds are highly toxic. Some of them may contain radioactive waste, which causes many diseases and poses risks to human health and aquatic organisms. Although infectious and polluting hazardous waste from health centers and hospitals constitutes the least percentage of the total amount of health waste, it poses a great danger to the individual, society, and the environment in general.

In many cases, the most harmful epidemics that may infiltrate the aquatic environment, such as infectious cholera, malaria, typhoid, plague, tuberculosis, hepatitis, AIDS, and others, are serious risks to public health, requiring wise planning and feasible management, including the collection, storage, transfer and even disposal [6].

Different studies were done to monitor or treat wastewater in Basra province [7,8]. The aim of this study included the assessment of wastewater by treatment units in some hospitals in the city of Basra.

2. Materials and Methods

The characteristics of the water flowing from the sewage system were studied in the targeted hospitals in four sites in the city of Basra, which is located in southern Iraq. It is positioned with Kuwait and Iran on the Shatt Al-Arab River and suffers from water scarcity [9]. In general, sanitation is connected to the city's rivers. Surface water resources mostly constitute the main inland water resource for domestic, industrial, and irrigation purposes. Hence, it is imperative to prevent and control river pollution and to have reliable information on river water quality [10]. Samples were collected from direct sources of water leaving hospitals, water coming out of the treatment plant, and samples of water flowing directly from hospitals before mixing with the public sewage water. The work was for three months, from December 2021 to March 2022. Samples were sent quickly to a laboratory (Fig. 2) for physical and chemical analysis, including pH, BOD_5, COD, TSS, Cl^-, SO_4, NO_3, and PO_4. pH is measured in the field by a Hana device model HI 9813-6; BOD_5, TSS, Cl^-, and NO_3 were measured according to the standard methods [11]. COD is measured by the digestive device model WTW CR 2200 and the COD Lovibond model device. SO_4 is measured by MD 600 device Lovibond model, while PO_4 is measured by [12] method.

Statistical Package for the Social Sciences (SPSS) was applied for the information on the quality of raw and treated wastewater in mentioned hospitals.

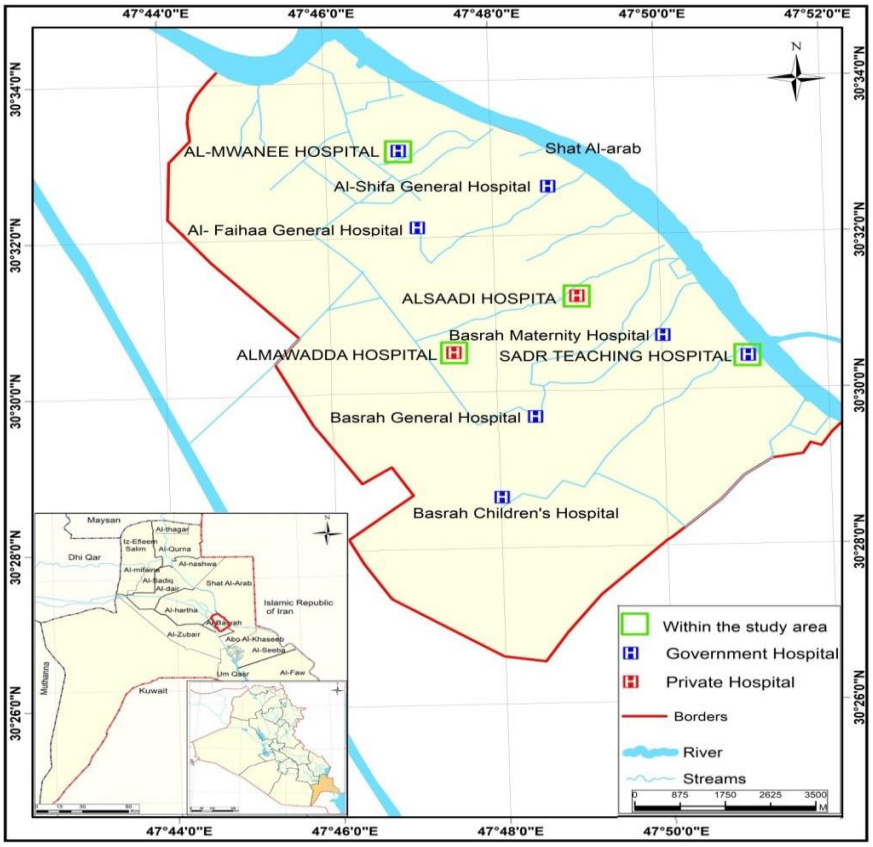

Figure 1. Location of the hospitals in Basra city.

Figure 2. The location of samples.

3. Results and Discussion

The wastewater treatment system in the studied hospitals was a media bed biofilms reactor with extended aeration. The hospital's wastewater passes through the bar screen and then the band screen after collection from different medical and non-medical locations. It then passes through the pumping station, which is a primary sedimentation basin in the wastewater treatment system. Despite the wastewater generated from hospitals containing toxic/infectious pollutants, it has similar characteristics to domestic wastewater [13]. Thus, dealing with hospital wastewater to minimize the potential risks for a population is considered a great challenge for healthcare facilities. Several parameters need to be evaluated to monitor the quality of hospital wastewater, and pH value is one of the important parameters because it is strongly related to water treatment plants and sewers [14]. In this study, the maximum pH value was 9.4 and 9.13 in Alsaadi hospital and Almawadda hospital, respectively, which is unlike that of [15], whereas the pH value of effluent wastewater was within the standards of the Integrated Reporting of Environmental Pollution Agency and consistent with [16].

Generally, the water in Basra tends to be light which may be due to the possibility of sovereignty, bicarbonate ions, and total alkalinity, which distinguish Iraqi water [17].

The minimum and maximum influent values of TSS were 210 and 530 for the Sadr teaching hospital and Almawadda hospital, respectively. This finding is consistent with [18] and [19], whereas for the BOD and COD influent values, the Al-Mwanee hospital had the highest value of 235, 293.75 (Table 1, 2; Fig. 3). According to our results (Fig. 4, 5), the removal efficiency of Sadr teaching hospital was higher than the other studied hospitals.

Previous studies agree that uncontrolled urban development in the region will likely increase water pollution in the future [20], and hence, expansion of the biochemical treatment stages in current treatment plants is important.

Table 1. Physical and chemical parameters for the influent and effluent in study hospitals.

Hospital Name	pH		TSS (mg/L)		BOD_5 (mg/L)		COD (mg/L)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
Al-sadr teaching hospital	9	8.6	210	150	225	13.3	281.25	16.625
Al-mwanee hospital	8.83	8.63	266.66	210	235	28.3	293.75	35.375
Alsaadi hospital	9.4	8.9	426.66	250	201.65	33.3	252.06	41.625
Almawadda hospital	9.13	8.96	530	340	203.3	20	254.125	25
LSD	0.969	1.168	276.02	233.65	76.578	23.536	128.191	26.929

Table 2. Chemical parameters for the influent and effluent in study hospitals.

Hospital Name	Cl^- (mg/L)		SO_4 (mg/L)		NO_3 (mg/L)		PO_4 (mg/L)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
SADR TEACHING HOSPITAL	968.06	1191.4	1202.18	938.38	11	5.82	65.96	13.86
AL-MWANEE HOSPITAL	876.83	1156.46	1161.8	1061.03	8.87	3.94	38.26	8.16
ALSAADI HOSPITAL	732.5	1273.03	2566.5	1636.66	9.76	5.49	31.86	18.65
ALMAWADDA HOSPITAL	974.23	1436.53	1485.33	680.66	5.24	4.32	30.84	11.24
LSD	1330.201	1738.265	1703.135	1184.331	16.709	9.724	48.874	31.430

Preliminary screening of waste with sewage in multiple basins should also be conducted to ensure higher efficiency and quality in the final treatment. Hospitals should also keep pace with the modern global development in medical sewage treatment plants and the introduction of bacteria treatment techniques to be a reserve for the work of the current stations. The generalization of this experiment in hospitals that lack treatment stations is necessary to enable them to support the current electrical treatment stations, especially outside the official working hours and during the period of power outages in health institutions.

Moreover, establishing laboratories attached to the current treatment stations is important to conduct continuous monitoring of the water quality spent after treatment and data tabulation of daily records of water quality. The necessity of converting existing stations into environmentally friendly treatment stations so that it does not affect the surrounding environment, especially the water ones should be addressed. The treated fluid resulting from water drainage after treatment should be taken advantage of for irrigation purposes for the surrounding area to provide a green environment surrounding the station.

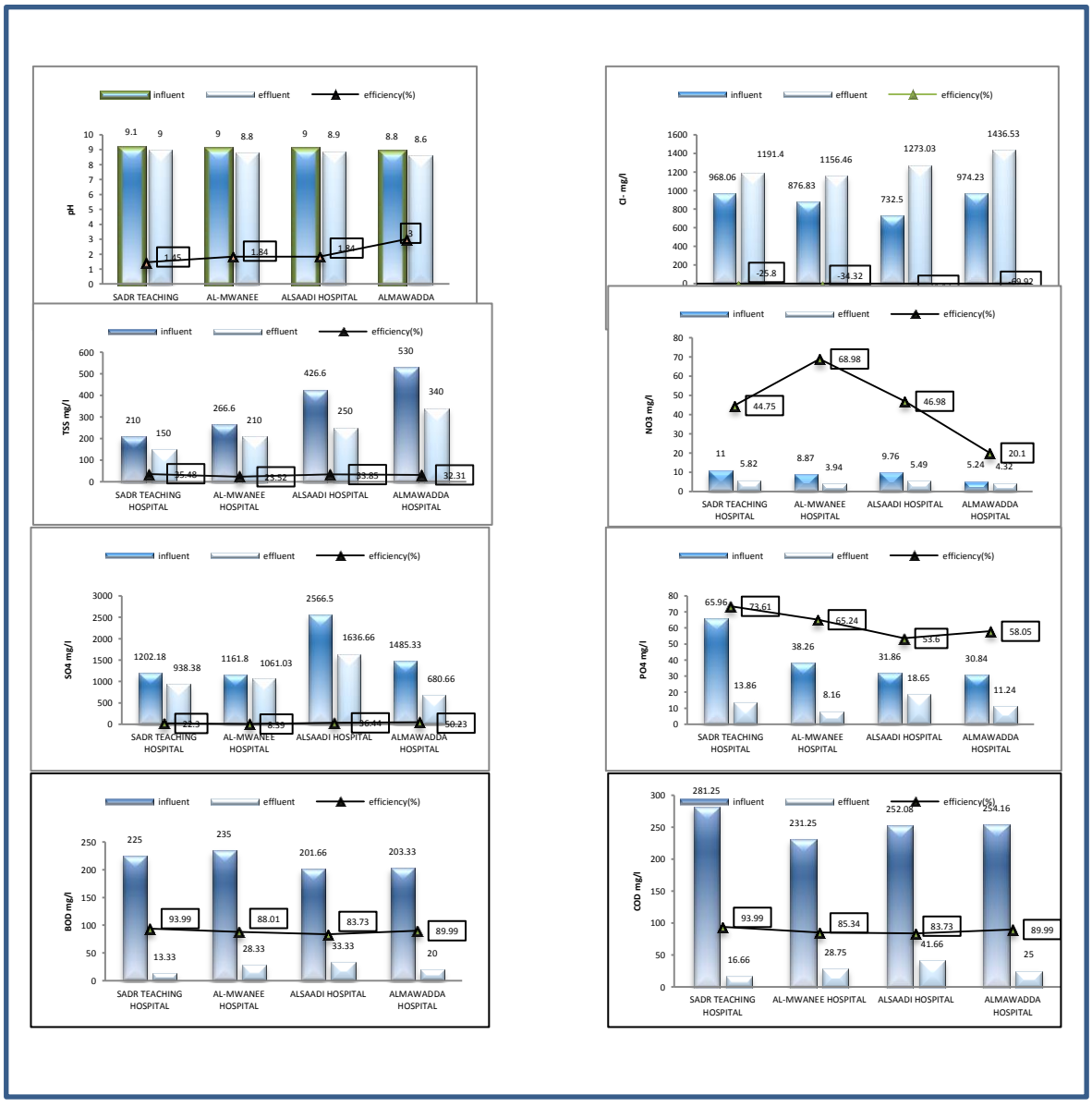

Figure 3. Physical and chemical parameters for the influent and effluent and Removal efficiency in study hospitals.

Regarding the chlorination efficiency of the studied hospitals, the highest efficiency was 74.42 in ALSaadi hospital. Chlorine is used to disinfect water to control the results.
The water becomes chemically pure and chlorine is easy to apply and requires a simple facility for disinfection. Storage and transportation are also economical. The highest value of sulfate removal efficiency was 50.23 at Al-Mawaddah National Hospital, and the lowest value of sulfate removal efficiency was 8.39 at Al-M Mwanee General Hospital, while the value of sulfate removal efficiency for Al-Sadr Teaching Hospital and Al-Saadi National Hospital was 22.3 and 36.44, respectively. These results may be due to the increased use of antiseptic materials in surgical operations, which increases zinc sulfate, which is thrown directly into the sewage network without treatment [21]. Even the urine and feces of patients from specific wards, such as oncology, contain higher amounts of antibiotics, cytotoxics, metabolites, and X-ray contrast media and contribute around 50–80% of total toxic discharge HWWs. The phosphorus in the current study of medical wastewater is within the standard limits, which could be due to an interaction that may increase phosphorus deposition [22]. Because the pH is relatively basic, phosphorous reacts with calcium and magnesium ions and precipitates in the form of a few calcium or magnesium phosphate compounds and achieves Solubility in the form of phosphate compounds [23]. Detergents also contain large amounts of phosphates, which are excreted in wastewater.

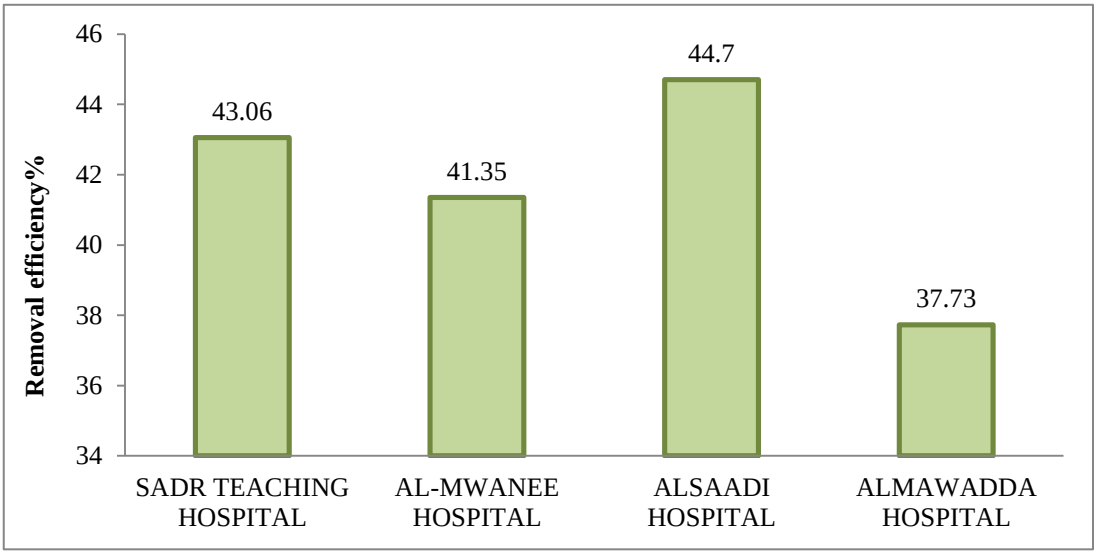

Figure 4. Removal efficiency of treatment plants.

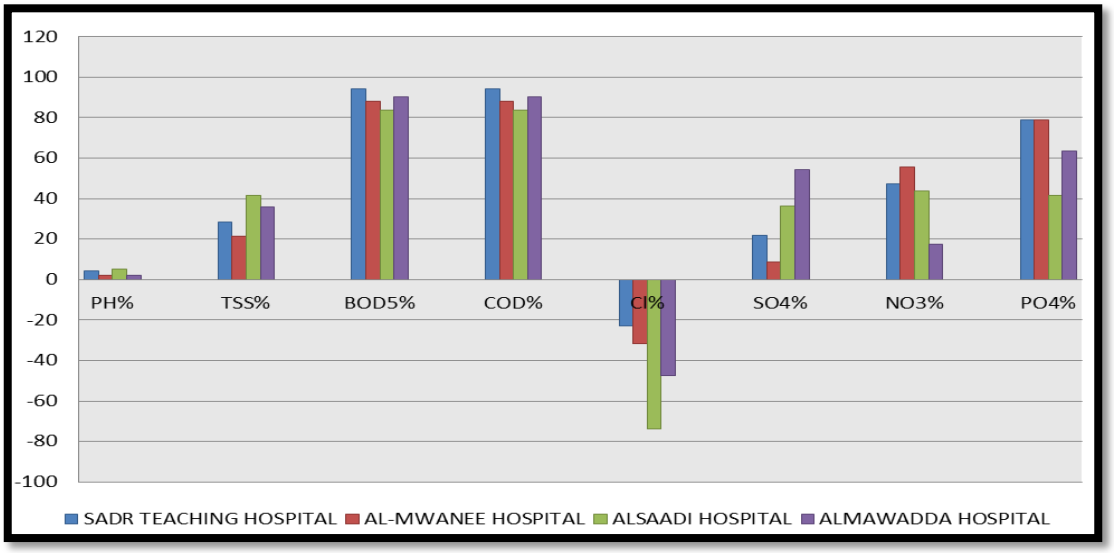

Figure 5. Percentages for treatment efficiency in Basra hospitals.

Conclusions

The selected hospitals have biological stations to treat the effluents. The results of the analysis of the samples of liquid medical drainage after treatment indicated they were acceptable in the selected hospitals, with most within the standard parameters, except for chlorides, sulfates and phosphates outside the standard parameters in the four hospitals and total dissolved solids in Al- Mwanee Hospital. The hospital administration supervises the continuous follow-up of the treatment plants and the provision of operational staff. The operational capacity in the selected treatment plants is commensurate with the hospital's capacity, as the General Ports Hospital has two biological stations, while the rest of the selected hospitals have one biological treatment plant, and the existing stations are from different international origins. The self-operating stations of Al-Sadr Teaching, Al-Mwanee, and Al-Mawaddah hospitals are better than the Al-Saadi Hospital stations that operate manually.

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