

# ASSESSMENT OF MEDICAL WASTEWATER DISCHARGE FROM HOSPITALS IN LIBYA CASE STUDY: HOSPITALS IN EAST PART OF LIBYA

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Farag A. EL Mabrouk<sup>1</sup>, Ramadan Sati<sup>2</sup>

1- Civil Engineering Department, Faculty of Engineering, Benghazi University, Libya.

2- Denpartment of Medical microbiology, Shaheed Hospital Sohil Elatrash Ophthalmology.

## ABSTRACT

Hospital waste management is a crucial environmental and public safety issue. Discharge water is one of the main sources of groundwater and rivers contamination if not treated efficiently Hospitals consume an important volume of water a day, and generate multiple amounts of infectious and hazardous polluted discharge water to the drain. These pollutants should be treated by the wastewater treatment plant (WWTP) of each hospital before release to the municipal drainage. This study aims at presenting the primary results on characterization of hospital wastewaters in some hospitals in Northeastern part of Libya. Four major hospitals were selected for this study ranging from 500 to 120 beds per hospital, none of them have a wastewater treatment plant, and the wastewater is rejected untreated to the public sewage. This addition of polluted wastewater will increase the load to the WWTPs of the city and reduce the efficiency of treatment processes leading to hazardous pollution in the future. Analysis of the concentration of biochemical oxygen demand, chemical oxygen demand, total suspended solids, sulfate, nitrate, nitrite, ammonia, chlorides, and oils and grease. Heavy metals were also investigated as Cr, Cd, Pb, Hg, Cu, Ni and Zn. The bacteriological parameters were carried out using the standard microbiological techniques. The study was conducted during the period of (15/4/2014 - 15/6/2014). The study showed an increase in the concentration of pollutants which is higher than the Libyan and WHO guidelines of raw wastewaters.

**KEYWORDS:** Evaluation, Wastewater, Discharge, Hospitals, Libya.

## INTRODUCTION

In the last years, increasing attention has been paid to the presence of emerging pollutants in surface and groundwater such as surfactants and pharmaceuticals that their sales are continuously increasing<sup>(1,2)</sup>. Then, improvement of the hospital waste management must receive increasing attention where hospitals generate a considerable amount of medical waste each year as a result of advance in medical services and products<sup>(3)</sup>.

Hospitals produce relatively large quantities of wastewater that may contain various potentially hazardous materials; therefore, the proper management of hospital wastewater is vital. Hospitals wastewater has similar quality to municipal wastewater and important sources of pharmaceuticals residues in all wastewater treatment plant (WWTP) effluents due to their inefficient removal in the conventional systems<sup>(4)</sup> Moreover, Hospital wastewater includes a great variety of micro-contaminants that are chemicals, heavy metals, disinfectants and specific detergents resulting from diagnosis, laboratory, research activities and medicine excretion by patients. Indeed, hospital wastewater may have an adverse impact on environmental and human health; therefore, the proper management of hospital wastewater quality and quantity is needed.

The main objective of this study was to evaluate of wastewater discharge from hospitals in Northeastern Part of Libya to present the primary results of both biological and chemical characterization of the hos-

pital wastewater and identifying some environmental stressors released by hospital activities. Indeed, the study of wastewater quality and quantity in the investigated governmental hospitals to determine the suitable method for wastewater management quality in the hospitals environment for risk assessment as well as risk management related to hospital effluents.

## MATERIALS AND METHODS

The wastewater samples were collected from four wastewater outlets from different units of the four hospitals of the study area. Biochemical Oxygen Demand (BOD<sub>5</sub>), Chemical Oxygen Demand (COD), pH and Total Suspended Solids (TSS) were tested for raw wastewater samples. pH was measured on-site. Total heavy metals (Cr, Cd, Pb, Hg, Cu, Ni and Zn) were determined according to "Standard Methods for the Examination of Water and Wastewater"<sup>(5)</sup>.

The bacteriological parameters monitored include total viable aerobic counts to isolate heterotrophic bacterial and fungal, total coliform counts, Escherichia coli, faecal streptococci counts and Clostridium perfringens counts according to the methods of Gerhardt et al.,<sup>(6)</sup>. The isolating and identification of bacterial isolates were carried out according to Bergey's Manual of Determinative Bacteriology<sup>(7)</sup> The physiochemical parameters were studied using the Standard Methods of APHA<sup>(5)</sup>.

These Parameters are considered as significant factors by Libyan Environmental General Authority (LEGA) Libya, for monitoring of hospital wastewater disposal<sup>(8)</sup>.

Sample analysis was done according to the standard methods<sup>(5)</sup>. All of the analyses were conducted in the

Correspondence and reprint request:

Farag A. EL Mabrouk

Civil Engineering Department, Faculty of Engineering, Benghazi University, Libya.

Email: faraj.elmabrouk@uob.edu.ly

water and wastewater laboratory of the General Company for Water and Wastewater

### RESULTS

The pH, TSS, BOD<sub>5</sub> and COD values are illustrated in (table 1) and (figure 1-a) show the average pH value of wastewater in the investigated hospitals. The average TSS concentration of wastewater in the studied hospitals is illustrated in (table 1), and (figure 1-b). The average BOD<sub>5</sub> and COD concentrations of wastewater in the investigated hospitals are represented in (table 1), and (figure 1-c). The aver-

age COD to BOD<sub>5</sub> ratio (COD/BOD<sub>5</sub>) of wastewater in the studied hospitals is illustrated in (figure 1-d). In the current study, Total coliform TC was indicator of the presence of microorganisms. Maximum and minimum concentrations of TC in wastewater of the studied hospitals were  $1.9 \times 10^9$  and  $2.5 \times 10^3$  MPN/100 mL.

In (table 2). The concentration of heavy metals such as (Cr, Cd, Pb, Hg, Cu, Ni and Zn) in the investigated hospitals effluent is presented.

(Table 1) The characteristics of raw wastewater in studied hospitals

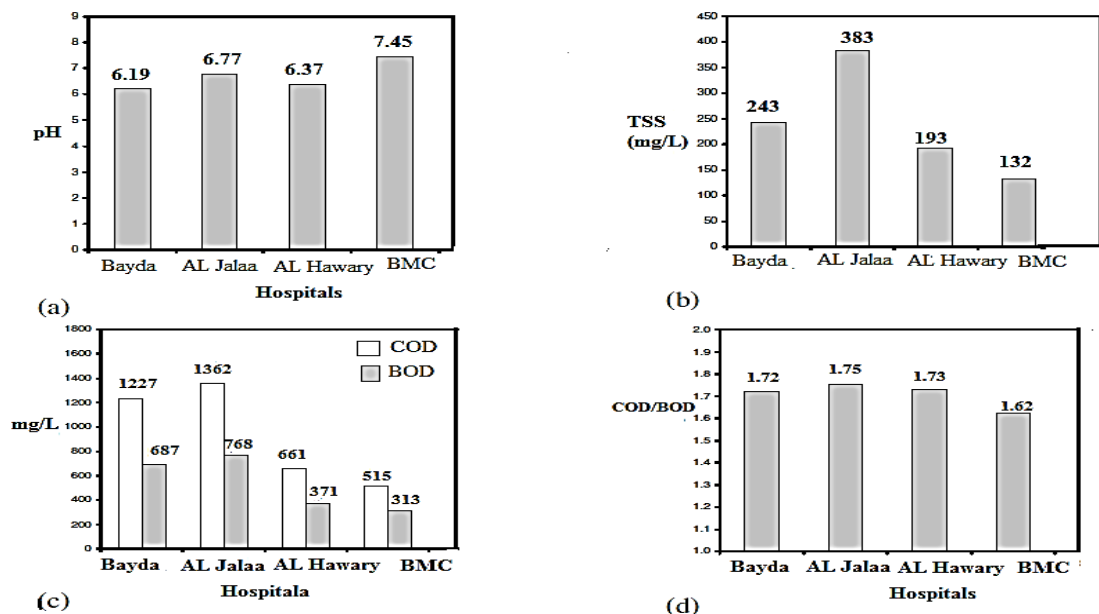
Hospital Name	pH	TSS (mg/L)	BOD <sub>5</sub> (mg/L)	COD (mg/L)	Total Coliform TC MPN/100 mL
Benghazi Medical Center (BMC)	7.45	132	313	515	$1.9 \times 10^9$
AL Jalaa Benghazi	6.77	383	768	1362	$3.3 \times 10^8$
AL Hawary Hospital	6.37	193	371	661	$4.1 \times 10^6$
AL Bayda Hospital	6.19	243	687	1227	$2.5 \times 10^3$
Mean	6.7	237.75	534.80	941.30	$2.23 \times 10^9$
<sup>†</sup> Libyan Environmental General Authority (EGA) Guidelines	6 - 9	600	500	1000	$1.0 \times 10^3$

<sup>†</sup>EGA guidelines for raw wastewater to the public network

(Table 2) Heavy Metals Concentration of Study Hospitals Wastewater

Hospital Name	Cr $\mu\text{g/L}$	Cd $\mu\text{g/L}$	Pb $\mu\text{g/L}$	Hg $\mu\text{g/L}$	Cu $\mu\text{g/L}$	Ni $\mu\text{g/L}$	Zn $\mu\text{g/L}$
Benghazi Medical Center (BMC)	44.5	3.93	44	14.4	59	33.6	469
AL Jalaa Benghazi	38.8	2.62	36	10.5	48.6	30.4	447
AL Hawary Hospital	39.6	2.10	24	7.6	51.2	27.5	427
AL Bayda Hospital	30.7	1.76	18	4.1	31.7	23.8	398
Mean	38.4	2.85	30.5	9.15	47.63	28.83	435.3
<sup>†</sup> Libyan Environmental General Authority (EGA) Guidelines	1200	20	1000	50	1200	2000	2600

<sup>†</sup>EGA guidelines for raw wastewater to the public network



(Figure 1) Quality characteristics of wastewater in the investigated hospitals;

(a) pH, (b) TSS, (c) COD and BOD<sub>5</sub> and (d) COD/BOD<sub>5</sub> ratio.

### DISCUSSION

The acidic or basic wastewater damages the wastewater collection and treatment facilities and prevents the biological treatment processes.<sup>(9)</sup> According to (figure 1-a), the minimum and maximum pH values were observed in the wastewater of AL

Bayda Hospital and Benghazi Medical Center (BMC), so the average pH value of wastewater in investigated hospitals was obtained to be 6.7. The mentioned range of pH (9–6) is suitable from the viewpoint of wastewater treatment processes and comparable to pH of domestic wastewater<sup>(10)</sup>. The

equivalent results were obtained in the other studies. Clean Technology Consultant (1994)<sup>(9)</sup> determined the wastewater pH value of a hospital in Thailand to be 7.2. In Indonesia, the range of pH in the hospital wastewater was obtained in range of (5.9 – 12.5)<sup>(6)</sup>.

One of the common parameters used in defining a wastewater is total suspended solids (TSS). According to (figure 1-b), the minimum and maximum TSS concentrations were obtained in the wastewater of Benghazi Medical Center (BMC) and AL Jalaa Benghazi Hospital, so the average TSS concentration of wastewater in the investigated hospitals was obtained 237.75 mg/L. The average TSS concentration of domestic wastewater is in the range of (120-600 mg/L) that is comparable to the results obtained in the investigation<sup>(8)</sup>.

The parameters of BOD<sub>5</sub> and COD are widely used to characterize the organic matter content of wastewater. According to Figure (1c), the minimum and maximum concentrations of BOD<sub>5</sub> were obtained in Benghazi Medical Center (BMC) and AL Jalaa Benghazi Hospital, so the average concentrations of BOD<sub>5</sub> were determined to be 313 and 768 mg/L, respectively. According to (figure 1-c), the minimum and maximum concentrations of COD were obtained in Benghazi Medical Center (BMC) and AL Bayda Hospital, so the average concentrations of COD were determined to be 515 and 1227 mg/L respectively. the most of the hospitals, the BOD<sub>5</sub> and COD concentrations of wastewater are almost equal to the domestic wastewater values<sup>(9)</sup>, determined the BOD<sub>5</sub> and COD concentrations of a hospital wastewater to be 113 and 232 mg/L, respectively. In Bangkok the BOD<sub>5</sub> and COD concentrations of a hospital wastewater were 300 and 430 mg/L, respectively<sup>(10)</sup>. According to (figure 1-d), the COD/BOD<sub>5</sub> ratio was in the range of (1.62-1.75), however in the domestic wastewater, the ratio is around 2.3. Therefore, the organic matters in the hospital wastewater had higher biodegradability in comparison with domestic wastewater. The high biodegradable of organic matters is very desirable from the viewpoint of wastewater treatment and promotes the efficiency of wastewater treatment plants<sup>(11)</sup>.

A serious concern regarding wastewater is the high content of enteric pathogens including bacteria, viruses, protozoa and helminthes, which are easily transmitted through water<sup>(12)</sup>. Wastewater of hospitals where patients with enteric diseases are hospitalized is a particular problem during outbreaks of diarrheal diseases<sup>(13)</sup>. In the present study, total coliforms (TC) were selected as indicator of the presence of microorganisms. According to (table 1), the minimum and maximum numbers of total coliforms TC were obtained in the wastewater effluents of AL Bayda Hospital and Benghazi Medical Center (BMC), so the average number of total coliforms in the investigated hospitals wastewater was obtained to be  $2.23 \times 10^9$  MPN/100 mL. The average number

of total coliforms in domestic wastewater is in the range of 106-10<sup>10</sup> MPN/100 mL that is comparable to the results obtained in the investigation.

The source of heavy metal in hospital wastewater can be originated from numerous sources such as from feces, cleaners, paints and wear and tear of utensils and equipment<sup>(2)</sup>. Certain heavy metals are micronutrients essential for plant growth (e.g., copper and zinc) and provide benefit to the crop. However, they can present problems for plant growth at excessive amount. Some are also not essential plant or animal and toxic to animals and human such as arsenic, cadmium and mercury. Heavy metals are a major concern in the treatment of water and wastewater due to their toxic and other detrimental effects.

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