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Water Treatment for Hemodialysis in Benghazi Medical Center (BMC)

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Authors' contributions

This work was carried out in collaboration among all authors. Author MOE designed the study. Author AAA wrote the protocol and wrote the first draft of the manuscript. Authors AOA and SBA managed the analyses of the study, organized the references and performed the statistical analysis. Author AAG managed the literature searches. Author NMB managed the recommendation. Author HG reviewed and organized the article paper. All authors read and approved the final manuscript.

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ABSTRACT

Background: A single 4-hour dialysis treatment can require up to 400 liters of water per week for dialysis patients compare that with healthy person who drinks less than 15 liters of water per week. Therefore, it is clearly important to know and monitor the chemical and microbiological purity of the dialysis water.

Aims: Determine the physicochemical and bacteriological characteristics of water used by hemodialysis services Isolate and identify fungi present in water systems of hemodialysis units in Benghazi Medical center (BMC) in Benghazi, Libya.

Methods: Analysis study carried out in hemodialysis unit in BMC collected samples from each places (A & B) sections.

Results: Six samples that target to chemical analysis and 32 samples for microbiological test, Chemical parameters of study area A and B for drinking and dialysis water were within international standards, but there was a minute of Calcium elevation in area B that was 3.3mg/l. No contamination with bacteria observed in all samples in section (A), the counts of yeasts and

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filamentous fungi investigated in the tap water, in the treated water, and dialysis machine in section B and *Penicillium spp* was the most frequent fungi.
Conclusions: Our study demonstrated that the tap and dialysis water success to meet the all-chemical and microbiological requirements in (A) area inside hospital of Benghazi center. In generally to prevent the risk of contaminants for hemodialysis patients need to a high water quality management program and development of water treatment system in hemodialysis centers.

Keywords: Bacterial; fungal formation; hemodialysis and water treatment system.

1. INTRODUCTION

Water treatment systems used in dialysis are the most sensitive situation that received by dialysis patients; they also cause one of the greatest dangers to the patients' health if they are not working at properly ways and because the microorganisms growth inside the surface of water systems.

A single 4-hour dialysis treatment can require up to 400 liters of water per week for dialysis patients compare that with healthy person who drinks less than 15 liters of water per week. Dialysis water come into direct contact with the patient's bloodstream through the semipermeable artificial membrane of the dialyzer.

Therefore, the necessary to water control and monitoring are considerable needed. Thus, the assessment of water and dialysate quality is vital for keeps of dialysis patients healthy. In dialysis department, quality of water based on three terms: chemical contaminants, endotoxins presence and microorganisms. Even though physical elements of the water such as temperature, PH, and total dissolved salt (TDS) are good indicators of its quality.

The use of many permeable modern membranes has been also increased the risk of water contamination. It is obviously important to know and monitor the chemical and microbiological contaminations of the dialysis water. Chemical contaminants can cause chemical toxicity and adverse effects if present at high enough concentrations, which cause clinical symptoms like; speech and motor difficulties, seizures, nausea, hypotension, and diarrhea. Each chemical cause a specific health effects; for example, sulfate (>200 mg/l) is associated with nausea, vomiting, and metabolic acidosis, while lead (52–65 µg/l) has caused abdominal pain and muscle weakness [1].

Bacterial contaminations of dialysis fluid can cause chronic inflammation and bacteremia, presence of bacteria in blood leading to sepsis. The endotoxins that may inter through dialyzer membrane that causes a pyrogenic reaction and high fever in the body.

Then, dialysis water treatment should remove chemical and microbial contaminants to stay at allowable limits by typical designs in preparation, distribution and storage conditions and keeps all the inner and outer surface of water pipes at high hygienic status.

Similarly substance for water pipes and surface exposed to water can leak in the water & have been toxicity in dialysis patient, therefore all water pipes in dialysis units should be made free of metals and are constructed of polyvinylchloride materials [2].

Most fungi are natural inhabitants of soil and water and are rare as pathogens in a natural host. However, dialysis patients have a weak immune system and are susceptible to a number of pathogens.

Some fungi are poisonous and pose a risk to human health at high concentrations or upon prolonged exposure It may cause allergies and some inflammation in immunocompromised people, but it is still largely neglected in the regulations for water quality and consumption, because the routine microbiological analysis of dialysis fluids does not include detection or measurement of fungi [3].

High quality of drinking water is the most important condition for hemodialysis. But is widely known, the access and quality of tap water is greatly different around the world and there is no globally accepted standardization made that regulates allowed levels of contaminants in drinking water.

Even though the problem of drinking water contamination is noticed and the regulation of drinking-water quality around the world is comprehensive and detailed therefore containing more measurement parameters. Some countries include Libya have lack local standards, The World Health Organization, WHO has set up guidelines to support and be the basis of risk assessment strategies to water contamination for countries [4,5].

On occasion, the water used to feed the water treatment plant in nephrology units in Benghazi Medical center is generally comply with drinking water requirements. A hospital water supply contains chemicals to ensure microbiological safety that add by engineering staff and the most commonly chemical that added to control microbiological contaminant level in drinking water is chlorine. If chlorine is arising from an acceptable level, it causes adverse health effects on dialysis patients. Therefore, those hemodialysis units should have a direct feed of tap water supply separate from that of the hospital water supply and medical.

1.1 Criteria for Dialysis Water

The recommended criteria for dialysis water developed by ISO 13959:2009 Water for hemodialysis and related therapies; specifically microbiological accounts and standards for chemical concentrates [6].

Maximum allowable level microbiological contaminants:

Following to quality requirements in the dialysis units provided in a series of German Standards Institute; ISO 13959:2009 Water for hemodialysis and related therapies for bacteriological accounts, less than 100 CFU / ml.

Endotoxin content ≤ 0.25 (IU/mL)

Maximum levels for chemical contaminant:

Table 1. List of Maximum concentration for Various Chemical Contaminants in pure water

Contaminant	Maximum Concentration (mg/L)
Calcium (Ca)	2
Magnesium(Mg)	4
Potassium(K)	8
Sodium(Na)	70
Total chlorine(Cl_2)	5
Nitrate (as No_3)	250
Chloramines(NH2Cl)	0.10
Sulphate (SO4)	250
Fluoride(F)	0.20
Lead(Pb)	0.0005
Mercury(Hg)	0.0002

Table 2. Maximum level of contaminants in drinking water by WHO drinking water standard

Contaminant	Maximum level mg/l
PH	6.5_8.5
Electrical charge (EC)	1500
Total dissolve salts (TDS)	1200
Total hard	500
Nitrate	50
Chlorine	250
Sodium	200
Calcium	200
Magnesium	50
Iron	0.30
Zinc	5
Manganese	0.10
Copper	0.10
Chromium	0.05
Cadmium	0.05
Lead	0.05

2. LITERATURE REVIEW

Vorbeck-Meister et al 1999 have been conducted a study on the Quality of water used for hemodialysis: bacteriological and chemical parameters in Vienna, Austria. The study has revealed that CFU values exceeding the European Pharmacopeia value [7].

Arvanitidou et al , have been investigated the counts of yeasts and fungi in dialysis unit in Greece 2000, *Aspergillus spp* and *Penicillium spp* were the most frequent fungus, while *Candida spp* were the most occurring yeasts [8].

Out of 321 samples of hemodialysis fluids, 213 from unit A (a governmental unit), 108 from unit B (a private unit), have collected from the water treatment system (WTS) by El-Koraie and co-workers in Egypt 2007. The dialysate samples showed higher acceptability at unit B (86.1%) than unit A (51.7%). Eleven samples detected as having TC while 57-100% of samples exceeded 0.25 EU/ml [9].

Pires-Gonc alves et al, 2008 were study done to identify and determine the occurrence and distribution of fungi in water used at a hemodialysis center which the results show *Fusarium spp* was the most genus found, while *Candida parapsilosis* was the yeast species [3].

El Emami et al , an assessed the quality of drinking water in Benghazi City Libya 2014 and found all physical parameters of the network water samples agree well with Libyan and World Health Organization (WHO) drinking water standards [10].

Suman et al 2013 found that the major organisms isolated were *Acinetobacter spp* and *Pseudomonas aeruginosa*, which swabs collected from the internal surfaces of the dialysis tubing from the dialysis units at Government Wenlock Hospital and Kasturba Medical College hospital in India [11].

A study carried out Izabel and co-authors in water systems in six hemodialysis units in Curitiba, Paran state, Brazil 2013. It found that 66% of the samples presented fungi, while black fungi were present in 46% of all samples [12].

In Iraq, Al-Naseri et al 2013 examined the quality of water in hemodialysis centers for total heterotrophic bacteria, endotoxin, and chemical contaminants. The results showed a fluctuation in the produced water quality that makes the produced water unaccepted when compared with international standards [13].

Braimoh and co-workers conducted a study on the Microbial quality of hemodialysis water, a survey of six centers in Lagos, Nigeria 2014. The results showed that none of the HD centers met EBPG/AAMI guidelines for microbial contaminants, as the mean levels of Escherichia coli in both feed and treated water were 441.7 ± 87.90 and 168.5 ± 64.03, respectively [14].

In one study on the bacteriological quality of treated water and dialysis in hemodialysis unit of a tertiary care hospital in 2015, it showed that thirty-six samples of treated water and 394 samples of dialysate analyzed for bacteriological contamination. 4 out of 36 (11.1%) samples of treated water and 44 out of 394 dialysate samples (11.2%) showed unacceptable bacteriological growth [15].

Shahryari et al 2016, studied the chemical and bacteriological characteristics of water used in dialysis centers of five hospitals in Isfahan, central Iran. Concentration of the determined chemicals (copper, zinc, sulfate, fluoride, chloramines and free chlorine) did not exceed the recommended concentration by (AAMI) [16].

Totaro et al 2017 in Italy, from nine-dialysis water plants at nephrology wards within the city examined for identify microbial and chemical hazards. The results showed that seven out of nine DW plants (78%) recorded negative results for all investigated parameters [17].

In Alexandria, Egypt 2018, a cross-sectional study carried out on 100 dialysis fluid samples randomly collected from a private HD center. The results showed that TC and fungi parameters found acceptable in all samples. Out of 70 samples from Type A machines 18 (25.7%) were acceptable and 52 (74.3%) were unacceptable for endotoxin [18].

In Palestine 2018 was water samples collected from all dialysis centers. The results showed that there chemical and microbiology parameters were not within the allowed limits in all the dialysis centers [19].

3. AIM OF THE STUDY

The objectives of this study is to ensure that hemodialysis water is safety and is compatible with internationally recognized standards.

The aims of presented study are:

1. Determine the physicochemical and bacteriological characteristics of water used by hemodialysis services in Benghazi Medical Center of the city of Benghazi, Libya.
2. Isolate and identify fungi present in water system of hemodialysis units in Benghazi Medical center (BMC) in Benghazi, Libya.

3.1 Significance of the Study

Water quality is one of the most important factor to ensure safe and effective hemodialysis process to patients. In week hemodialysis patients exposed to approximately 400 l of water used for dialysate production, so it is clearly important to know and monitor the chemical and microbiological purity of the dialysis water. Even though, the main source of dialysis water is the public (tap) water that used after purification by different types of treatment, therefore, it is essential noted that water used is within WHO guidelines. To our knowledge, this is the first study in Benghazi evaluating the mycological quality of water used during hemodialysis processes and because data on fungal presence in dialysis water are very little. Therefore, this study conducted to provide correct database on the occurrence of fungi in dialysis water treatment system in Benghazi medical center.

4. METHODS AND MATERIALS

4.1 Study Site

The hospital′s local water supply supplemented by groundwater transported from along the Man-made River to desalination power plant that found inside hospital. Benghazi Medical Center hospital has pipe water supply system. This piped distributed in network connection used for drinking and other medical uses. Hemodialysis unit opened on November 2013 with 30 dialysis patients in section A which section B is not working yet.

Each section (A & B) have water treatment plant are supplied with water by pipe network connection.

4.2 Time and Study Design

The laboratory-based study carried out in hemodialysis unit in Benghazi medical center, Benghazi, Libya.

From January to 10 March 2020, samples of water from section (A & B) collected with antiseptic precautions.

To avoid any variance in sample examination all sample were analyzed in the same methods by the same technicians.

The samples sent and test immediately after collection in Al-Hwarri lap Institute of water quality.

4.3 Sampling

From each (A & B) hemodialysis sections, has examined four samples from each site in duplicate.
Samples collected using a “clean catch” technique to minimize contamination of the sample.

4.4 Sample Collection Sites

Site 1: At the point where the tap water receiving.
Site 2 : At the point where the water leaves the softener tank.
Site 3 : At the point after reverse osmosis (RO).
Site 4 : At the dialysis machine.

4.4 Chemical Test

The sample ports that used to collect the samples rinsed for at least five minutes and wiped with alcohol swabs prior to sample collection. Water samples took in a 0.5-liter container.

4.5 For Measuring PH

Switch on the pH meter, and allow at least 30 minutes warming up. The pH of the sample is then measured after setting up the pH meter with buffer solutions.

4.6 Electrical Conductivity

Switch on the EC meter and allow at least 15 minutes warming up. The electrical conductivity of the sample is then measured after checking the EC standard 1413 µS/cm.

Conductivity is a measure of the ability of a solution to conduct electricity. The units used are µS/cm. The electrical conductivity (EC) is directly related to the dissolved ionic species present in water samples.

Total dissolved solids: TDS = EC * 0.65

4.7 Total alkalinity

The sample is titrated with a standard solution of hydrochloric acid and the end-point determined using indicators, using phenolphthalein and bromocresol green-methyl red indicator. The phenolphthalein end- point represents the titration of all the hydroxide and half the carbonate present in the sample. The combined indicator represents the total alkalinity in the sample.

4.8 Chloride

Samples are titrated by the Mohr method using standard silver nitrate solution and potassium chromate indicator. Chloride is precipitated silver chloride in the presence of chromate ion. The red colored silver chromate being more soluble is not precipitated permanently until virtually all the chloride has reacted.

4.9 Total Hardness

Transfer all operations to the fume cupboard, Transfer by pipette 50 ml of sample into a clean 250 ml conical flask, Add 2.0 ml of ammonia buffer to the sample and swirl to mix and Add 1.0 ml sodium sulphide reagent. Finally, add about 3 drops of Calmagite indicator solution and mix, the initial color should be wine-red against a white background, the end-point is approached a blue color observed but a reddish tinge will still be visible.

4.10 Calcium Hardness

The sample is titrated with a standard solution of (ethylenediaminetetraacetate EDTA) at a pH of 10.0, and the end-point determined using indicators. When using 0.05% Calmagite indicator, the initial color of the sample solution is wine red. The end-point obtained when the sample solution color turns from wine-red to pure blue.

Calcium ion ca^{+2} = calcium hard* 0.25

4.11 Magnesium Hardness

Magnesium hard =Total hard – Calcium hard
Magnesium ion Mg^{+2} = magnesium hard* 0.4

4.12 Sodium and Potassium

The sample is analyses by flame photometer.

4.13 Microbiological Test

Water sampled in sterilized glass container of 100 ml, which collected after let water run for at least 5 min to remove residual alcohol and any external contaminations. Gloves and gown should be worn when collecting the samples to make sure there is no bacteria in sample.

4.14 Enterolert Test Kit Methods

The Enterolert procedure was employed according to the manufacturer's instructions (IDEXX Laboratories, , Westbrook United States, EPA 1989) were used to encounter the total count (TC) of bacteria, *total coliform* (T.C.F), *fecal coliform* (F.C.F), *streptococcus feacales*. The results expressed as the Colony Forming Unit (CFU) per 100 ml.

4.15 Enterolert Enumeration Steps

1. Add reagent of one pack to a 100 mL water sample in a sterile bottle.
2. Cap the bottle and shake until dissolved.
3. Shed the sample into a Quanti-Tray
4. Seal in an IDEXX Quanti-Tray Sealer.
5. Place the sealed tray in a 41°C incubator for 24 hours.
6. After incubation the tray was notice in a dark room by placing it under and within 12 cm of a 365 nm wavelength ultraviolet light with a 6 Watt bulb. Put face light away from your eyes and towards the sample.
7. The results read according to the Result Interpretation table below. Count the number of positive wells and refer to the Most Probable Numbers (MPN) table provided with the trays to obtain a Most Probable Number.

4.16 Fungal Test

Living cells of fungi performed using membrane filter (Millipore, Billerica, USA, 0.45 µm) as prescribed by the American Public Health Association [20]. The Filters transferred to Sabouraud dextrose agar and incubate at 25C°

for 6 days checked daily for assessment of fungi growth.

The results expressed as positive and negative appearance.

5. RESULTS

All microbiological and chemical test performed in duplicate. The results expressed as the mean value.

A total of 6 samples from each sides (a &b) that collected in duplicate for chemical test from three sites

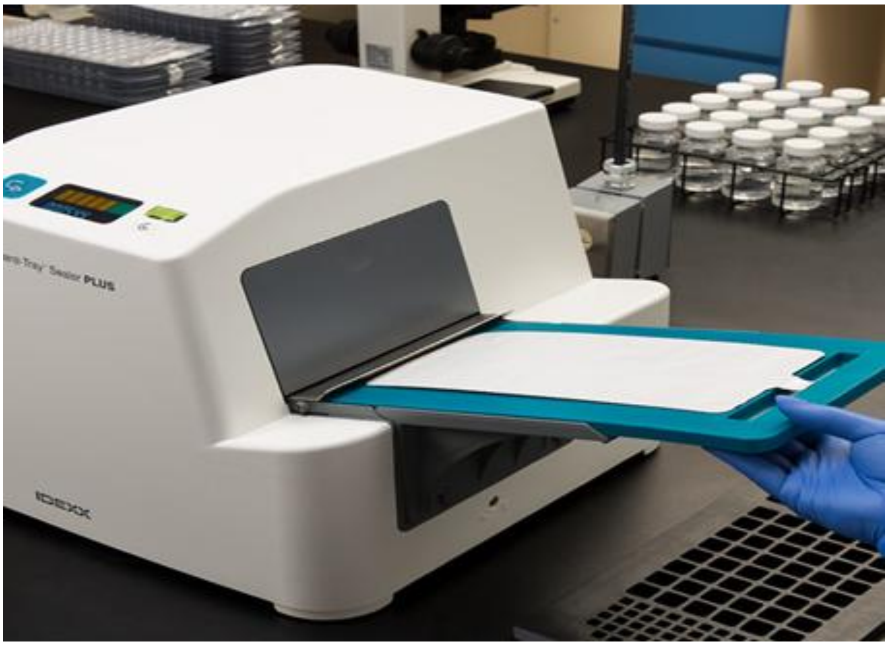
Site 1: At the point where the tap water receiving
Site 2: At the point where the water leaves the softener tank
Site 3: At the point after reverse osmosis (RO)

As shown in (Table 4) which illustrate chemical parameters of municipal drinking water in comparison to WHO drinking water standards.

While; Chemical parameters of dialysis water in comparing with International Organization for Standardization ISO 13959:2009 standard show in (Table 5) .

32 samples from each sides (A & B) that also collected in duplicate for microbiological test from four sites as shown in (Table 6)

- Site 1: At the point where the tap water receiving
- Site 2: at the point where the water leaves the softener tank
- Site 3: at the point after reverse osmosis (RO)
- Site 4: at the dialysis machine (only one machine from each side**)**



https://www.idexx.com/en/water/water-products-services/quanti-tray-system/

Table 3. Result interpretation

Result	Appearance
Positive for total count	Pink color equal to or greater than the comparator*
Positive for total coliforms and fecal coliform	Yellow equal to or greater than the comparator
Positive for E. coli	Yellow and fluorescence equal to or greater than the comparator
Positive for streptococcus feacales	Yellow equal to or greater than the comparator

**Comparator: the Colilert comparator is a liquid color its uses to distinguishing a minimal positive from a negative test result*

Table 4. Mean values of chemical parameters of municipal drinking water from the hemodialysis centers of A& B region in comparison to WHO drinking water standards

Measurements	WHO Guidelines	Sample Place	
		Section A Tap water	Section B Tap water
Temperature	Not listed	22.3	19.3
PH	8.5 - 6.5	7.8	7.6
Electrical charge	1500	517.6	980
Total Dissolve Salts (TDS)	1200 mg/l	336.2	643.3
Total alkaline	Not listed	104.09	196
Ca – Hard	Not listed	48.04	80
Total – Hard	500 mg/l	100	176
Nitrate (mg/l)	50 mg/l	10.2	12.3
Chlorine(mg/l)	250 mg/l	76	22.7
Sodium (mg/l)	200 mg/l	126.2	180

Table 5. Mean values of chemical parameters of dialysis water from the hemodialysis centers of A&B area in comparison to ISO 13959:2009 standard

Measurement	ISO	Sample place							
		Section A				Section B			
		Tap water	Softener water	Reverse osmosis	Machine water	Tap water	Softener water	Reverse osmosis	Machine water
Total count (cfu/ml)	<100	0.02	0.4	0.1	0	1.04	0.675	0.040	0.01
Total coliform (cfu/ml)	<100	0	0	0	0	0	0	0	0
Fecal coliform (cfu/ml)	<100	0	0	0	0	0	0	0	0
E.coli (cfu/ml)	<100	0	0	0	0	0	0	0	0
Streptococcus Feacales (cfu/ml)	<100	0	0	0	0	0	0	0	0
Fungi		Negative				Positive			

Table 6. Mean values of total heterotrophic bacteria (c.f.u. /ml), total fecal coliforms, *E.coli* , *fecal streptococci spp*. (c.f.u./100 ml) in tap water, treated water for dialysis, after RO, and hemodialysis machines water samples in both A&B region. Occurrence of fungal isolates in positive result for section B

Parameter (mg/L)	**ISO standards (mg/L)**	**Sample place**			
		Section A		**Section B**	
		Softener water	**Reverse osmosis**	**Softener water**	Reverse osmosis
Temperature	Not listed	21.9	21.9	19.2	20
PH	6.5-8.5	8.2	7.4	7.4	8
Electrical charge	1500	1064	34.2	1130	39.5
Total dissolve salts (TDS)	1200 mg/l	691	22.2	739	25.6
Total alkaline	Not listed	411.09	19.66	236	16
Ca – Hard	Not listed	48	14	12	8
Total – Hard	500	102	20	24	24
Nitrate (mg/l)	2	1.3	0.41	1.15	0.67
Chlorine (mg/l)	0.1	1.32	0.1	1.8	0.3
Sodium (mg/l)	70	25	0.36	28.7	1.3
Calcium (mg/l)	2	3.3	0.26	0.47	3.3
Magnesium (mg/l)	4	1.7	1.7	2.7	3.2
Potassium (mg/l)	8	4	1	2	1

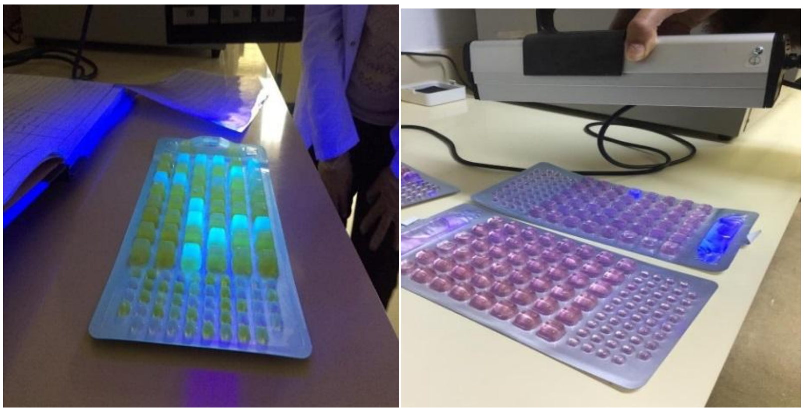


Fig. 1. Quanti Tray Sealer

Fig. 2. Fungal test

6. DISCUSSION

The main water sources for hemodialysis facilities are local drinking water suppliers, In general some substances added to municipal water supplies for public health reasons at level that never cause threat to healthy individuals, but can cause injury to renal failure patients if these substances are remain in the water used for dialysis. Therefore, the chemical purity of water is important to avoid any harmful to patients [21]

The results of study revealed that the range values of Temperature, pH, and TDS (total dissolve salts), of A and B sections in Nephrology departments at Benghazi Medical center were fall within the WHO's accepted range for drinking water quality. However, a total hardness measurement revealed that all samples fell within the acceptable limit that was in section A 100 mg/L while 176 mg/L in section B.

On other study, general water physical quality indicators in Benghazi city was also at WHO drinking water standards [10].

Chemical parameters of study in both A and B sections (chlorine, Nitrates, calcium, magnesium, Sodium and Potassium) measured according to the WHO guidelines for drinking water. The results showed that all chemical parameters were within the WHO's accepted range for drinking water quality. This is almost disagree to report of another study among Nephrology depart in Italy [17] and Austria [7]. Therefore, drinking water of the network of water distribution of Benghazi Medical center has high quality.

Patients exposed to 120−200 L of dialysis solution during each dialysis treatment. Even though small weight of chemical contaminants in the dialysis solution can enter to the blood and accumulate in the body in the absence of renal excretion [22]. Therefore, the chemical quality of dialysis water is essential.

The present study revealed that dialysis solution chemical parameters are (NO3, CL, Na, K, and Mg) according to ISO 13959:2009 Water for hemodialysis standard specifically for the chemical concentrates in both sections (A & B).

However, there was a minute elevation in calcium in B area 3.3mg/l, in longitudinal studies it found that raising Calcium concentration in dialysis fluid from 5.0 to 6.0 mg./100 ml caused nausea and vomiting in some patients [23]. So that the membranes of reverse osmosis and the water after softeners system in unit B need to checking and regular preventive maintenance in department as soon as possible.

These results have agreed with results of study done on Nigeria [24] which chlorine and potassium levels met AAMI standards after water treatment and is in line with study done in Iran [16] because free chlorine did not exceed the recommended concentration by the Association for the Advancement of Medical Instrumentation (AAMI).

Other than , disagreed with finding of study in other country for example Iraq in which chemical analysis showed that the dialysis water has elevated in aluminum concentration therefore suggested that hemodialysis centers need to be monitoring and preventive maintenance to ensure high quality of dialysis water [13]. In Palestine 2018 chemical contaminants were not within acceptable limits in dialysis water for present an urgent steps need to be taken to improve water quality used in Palestinian dialysis centers [19]. Therefore, six monthly full laboratories testing for chemicals shall be done at raw water point, pre and post RO in dialysis units [23].

The water used to prepare dialysis solution are more susceptible to microbiologic contamination by bacteria some of which can be cross dialyzer membranes and enter the bloodstream to produce pyrogenic reactions to patients, since patients with end-stage renal disease are suffering from the low function of the immune system [22]. Moreover, Monthly test for microbiological count and endotoxin are necessary [23].

In this study, results showed that no contamination with bacteria was observed in all samples in section (A), Total count in tap water was 0.02 which values not exceeding the 100 CFU / ml. after softener was 0.4 CFU /ml while in section (B), total account was 1.04 CFU /ml in tap water and 0.01 from dialysis machine while in section A was 0.00 this is probably due to in section B the place that used for storage water is old tank and water is stagnant because section B under maintenance from a year 2018. However, an appropriately designed and correctly maintained water treatment system to safeguard patients is necessary.

This finding have agreed with the situation in Central Iran there is no contamination with heterotrophic bacteria was observed in all samples [16] while other studies reported in Greece the most commonly isolated bacteria were *pseudomonas spp* found in 22.2% of treated water, 36.2% for total coliforms in dialysate samples [25]. Same as the study done in Nigeria which was *E. coli* the commonest organism isolated in treated water in all the centers [14].

The presence fungi in treated water and dialysate solution have become important pathogens because of the severity of infections to dialysis patients. Fungal infection is usually associated with vascular access in hemodialysis patients that may cause fatal infections [3]. The result revealed that the counts of yeasts and filamentous fungi were investigated in the tap water, in the treated water, and dialysis machine in section B and *Penicillium spp* was the most frequent fungi, similar results have been showed by other investigators Arvanitidou [8] Pires-Goncalves [3].

This occurrence perhaps because the old design of water treatment system in B unit, and lack monitoring for dialysis machines. Even though the presents of fungi in hemodialysis water treatment system cause potential risk for dialysis patients. So continuous maintenance and monitoring water treatment system needed, also give austere program of cleaning, disinfection, and maintenance of dialysis machine.

Compare to unit A the result was negative for fungal growth at all samples. This result is disagreed with finding of study in Brazil 2013 [12]. No defined standards for fungal counts in hemodialysis water thus fault the comparison between studies. Few countries include Sweden that involves fungi upper limit for microbial water contamination is should be less than 10 CFU/ml.

The aseptic practices and microbiological quality control of the water supplying hemodialysis units need to be applying in order not only for the monitoring of bacteria, but also for fungi [26].

7. CONCLUSION

Our study demonstrated that the tap and dialysis water success to meet the all-chemical and microbiological requirements in (A) area inside hospital of Benghazi center. Positive fugal growth was at B area. In generally to prevent the risk of contaminants for hemodialysis patients need to a high water quality management program and development of water treatment system in hemodialysis centers. In addition, suitable disinfection protocol to better control of bacterial and fungal formation.

8. RECOMMENDATIONS

Every week, hemodialysis patients exposed to 400 l of water used for the production of dialysis fluids therefore it is important to:

1. Periodic monitor the chemical and microbiological purity of dialysis water.
2. An appropriate monitoring system and preventive maintenance is the only way of detecting hazards at an early stage, to ensure a high degree of therapeutically safety and good quality of water for the patient.
3. Congenial disinfection program in water treatment system to ensures better control of bacterial and fungal growth.
4. Issuing legislations and updating it to organize works with the program for monitoring the quality of dialysis water.
5. Additional studies are required to establish the clinical finding of these data.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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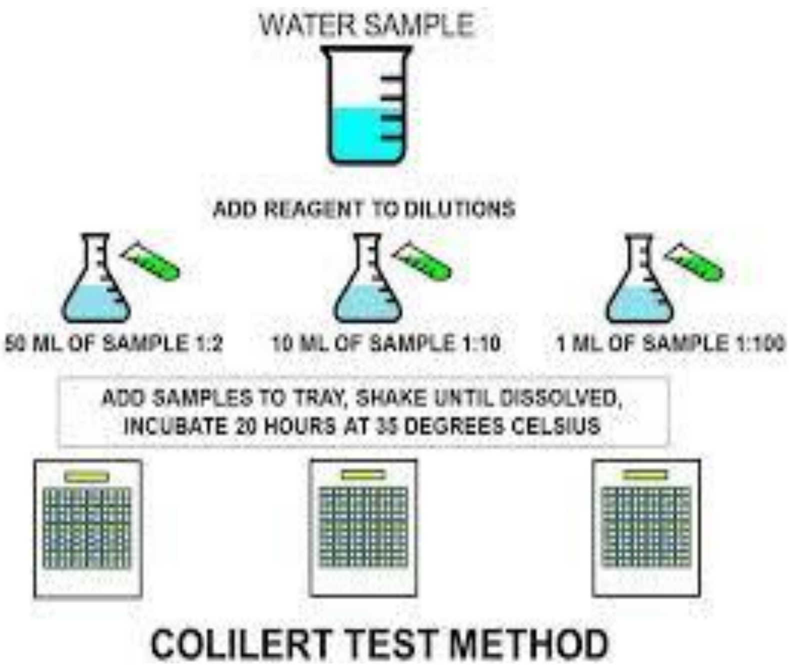
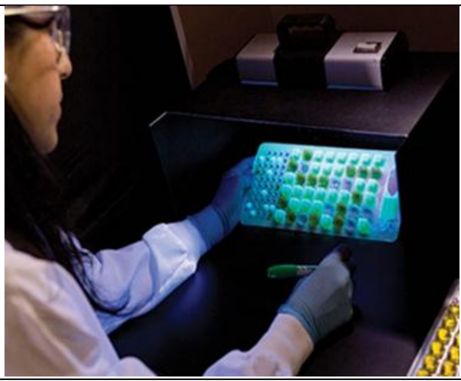
APPENDIX





http://www.gepgis.eu/en/wpo8 /

Probable Numbers (MPN) Table

LE 9221.IV. MPN INDEX AND 95% CONFIDENCE LIMITS FOR VARIOUS COMBINATIONS OF POSITIVE RESULTS WHEN FIVE TUBES ARE USED PER
ITION (10 ML, 1.0 ML, 0.1 ML)

Combination of Positives	MPN Index/ 100 mL	95% Confidence Limits		Combination of Positives	MPN Index/ 100 mL	95% Confidence Limits	
		Lower	Upper			Lower	Upper
				4-2-0	22	9.0	56
0-0-0	<2	—	—	4-2-1	26	12	65
0-0-1	2	1.0	10	4-3-0	27	12	67
0-1-0	2	1.0	10	4-3-1	33	15	77
0-2-0	4	1.0	13	4-4-0	34	16	80
				5-0-0	23	9.0	86
1-0-0	2	1.0	11	5-0-1	30	10	110
1-0-1	4	1.0	15	5-0-2	40	20	140
1-1-0	4	1.0	15	5-1-0	30	10	120
1-1-1	6	2.0	18	5-1-1	50	20	150
1-2-0	6	2.0	18	5-1-2	60	30	180
2-0-0	4	1.0	17	5-2-0	50	20	170
2-0-1	7	2.0	20	5-2-1	70	30	210
2-1-0	7	2.0	21	5-2-2	90	40	250
2-1-1	9	3.0	24	5-3-0	80	30	250
2-2-0	9	3.0	25	5-3-1	110	40	300
2-3-0	12	5.0	29	5-3-2	140	60	360
3-0-0	8	3.0	24	5-3-3	170	80	410
3-0-1	11	4.0	29	5-4-0	130	50	390
3-1-0	11	4.0	29	5-4-1	170	70	480
3-1-1	14	6.0	35	5-4-2	220	100	580
3-2-0	14	6.0	35	5-4-3	280	120	690
3-2-1	17	7.0	40	5-4-4	350	160	820
				5-5-0	240	100	940
4-0-0	13	5.0	38	5-5-1	300	100	1300
4-0-1	17	7.0	45	5-5-2	500	200	2000
4-1-0	17	7.0	46	5-5-3	900	300	2900
4-1-1	21	9.0	55	5-5-4	1600	600	5300
4-1-2	26	12	63	5-5-5	>1600	—	—

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