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Research Article

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The microbiological quality of water in Ibn Sina Hospital of Rabat (Morocco)

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ABSTRACT

Water is an essential element for the functioning of health facilities, but it can be a source of serious infections in case of contamination, especially for the most vulnerable patients. The main health risks associated with the use of water in health facilities must be identified and evaluated to determine how to implement and control these risks.
This is a prospective and transversal study over a period of three months (March, April, May, 2013) in the bacteriology laboratory of the IBN SINA Hospital in Rabat, which aims for bacteriological analysis of four types of water collected in the services in our study. Of 98 water samples analyzed, 40 were non-compliant (either 40.81%), including 22/38 (57.89%) drinking water, 14/38 (36.84%) water for standard care, 2/13 (15.38%) water bacteriologically mastered, 3/9 (33.3%) water for hemodialysis. In case of abnormal results, effective corrective action must be implemented to improve water quality and protect the most fragile patients.

Keywords: compliant; microbiology; water; Ibn Sina Hospital; Morocco

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INTRODUCTION

With the pollution of water caused by human activities, serious health problems and other economic costs related to water treatment, remediation and locating a new water supply, become evident [1]. Drinking water contamination with different chemicals and heavy metals, released from different anthropogenic sources has become a global concern [2; 3; 4].

The main source of microbiological contamination is microorganisms from human or animal excreta, which reaches humans through contaminated water from wastewater, landfills, or wastewater treatment stations, causing serious health problems [5].

The hospitals discharge a high volume of wastewater, with variable physicochemical composition, including chemicals, pharmaceutical toxic substances, radioactive elements and pathogenic microorganisms [6; 7]. Moreover, the volume of wastewater from these hospital formations varies from 400 to 1200 liters/bed/day [8; 9]. Thus, water consumption by American hospitals is of the order of 968 l/bed/day [10] while in the French university hospitals this volume is estimated to 750 l/bed/day [11]. Mean while in developed countries the consumption seems to be around 500 l/bed/day [12]. However, the minimum domestic water consumption is about 100 l/capita/day [13].

This high volume which contains a many variable substances could generate ecological imbalances in the receiving environment [14; 15]. The complexity of the effluent quality is mainly due to the use of chemicals and pharmaceuticals substances [16]. Several studies have shown that microorganisms may be unable to degrade these drugs [17; 18; 19) that can be detected in water samples, sediment and sludge in rivers and oceans [20; 21; 22; 23].

In Morocco, a major wastewater volume is rejected by the rural and urban areas. Thus, in the cities the hospitals contribute to increase this volume of water discharged. The aim of this study is the focus on the bacteriological characterization of liquid discharged by Ibn Sina Hospital in Rabat city of Morocco.

EXPERIMENTAL SECTION

2.1. Localization of the sampling point

Mohammed V hospital is the largest hospital of the Rabat-Sale-Zemmour-Zaer region (Fig.1). It is among the largest health structures in Morocco.

24 sampling point selected was located on a main drain receiving 3/4 of the aqueous waste of the hospital. In particular, it received the effluents of the following departments: Emergency Block, Block central operative CCVA, Surgery B, Surgery C, Plastic Surgery, Dermatology, Endoscopy, Dialysis, Laboratory of Anatomy-Pathology, Laboratory of Hematology, Bacteriology Laboratory, Laboratory of Biochemistry, Laboratory of Parasitology, the emergency UPM, the emergency UPC, Medicine A, Medicine B, Medicine C, Nephrology, Intensive Care Central, Surgical Intensive Care, Sterilization emergency, Interventional unit, Urology A.

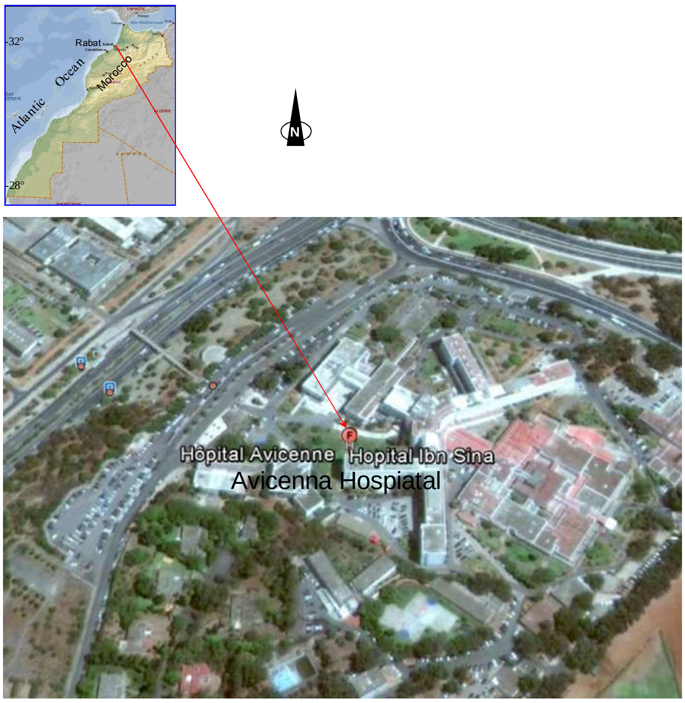

Fig.1: Location of the Mohamed V hospital (Avicenna) of Rabat [source: 24]

2.2. Microbiological sampling and analysis methods

Microbiological parameters were collected during March, April and May, 2013 in sterile bottles and immediately transported in a cooler a temperature less than 4°C to the laboratory of the ISH (Avicenna, Morocco).

Microbiological tests included Flora total aerobic mesophilic (TAMF), Total coliform (TC), Fecal coliform (FC), fecal streptococci (FS), Revivifiable aerobic flora (RAF) and *Pseudomonas Aeruginosa* (PA). All microbiological analyses were carried out in accordance with the procedures described by the American Public Health Association [25].

The identification and research of pathogens were performed according to the conventional method by isolation on selective medium and biochemical environments identifications [26; 27]. This identification was confirmed by the API tests and BD-phoenix in microbiology department in ISH.

2.3. Statistical Analysis

The statistical treatment of analytical data was performed according to the Student test using SPSS software. This test was applied to the annual averages of the parameters measured every month in the water samples from the Ibn Sina Hospital.

RESULTS

3.1. Drinking water during 2013-2014

Out of 38 water samples from drinking water analyzed in ISH for TAMF, TC, FC and FS, 4.51%, 3.11%, 0% and 0.22% of the samples exceeded the WHO limits for TAMF, TC, FC and FS, respectively, as shown in Table 1.

Table 1. Microbiological quality of drinking water samples in ISH during 2013-2014

Parameters	Units	Concentrations	A	B	C
TAMF	CFU/100 ml	$14.22\ 10^4$	38	32	84.21%
TC	CFU/100 ml	$35.67\ 10^2$	38	21	55.26%
FC	CFU/100 ml	0	38	0	0%
FS	CFU/100 ml	0.26	38	3	7.89%

A*: total number of sampling point;* ***B****: number of sampling points non-compliant;* ***C****: rate at not conformity*

Total aerobic bacterial counts in water samples ranged from 0 to $14.22\ 10^4$ CFU/100ml. Indeed, lower mean CF concentrations (0 CFU/100ml) were detected in drinking water. But higher mean TAMF concentrations ($14.22\ 10^4$ CFU/ml) were obtained in drinking water of the ISH (Table 1).

Concerning all samples, Non-compliant NC (Drinking water) = total number of non-compliant samples/total number of the samples=0.578 (57.89%).

3.2. Drinking water in 2015-2016

According to the analyses that have been done at the level of the same sampling points were non-reproductive. On the other hand, a total absence of germs (TAMF, TC, FC and FS) of drinking water does not found (Table 2).

Table 2. Microbiological quality of drinking water samples in ISH during 2015-2016

Parameters	Units	Concentrations	A	B	C
TAMF	CFU/100 ml	0	38	32	84.21%
TC	CFU/100 ml	0	38	21	55.26%
FC	CFU/100 ml	0	38	0	0%
FS	CFU/100 ml	0	38	3	7.89%

The presence of germs in the first sampling could explain by an analytical error during the handling of the samples or a leak that has been repaired.

3.3. Water for care standards

Out of 38 water samples from water for care standards analysed in ISH for Revivifiable aerobic flora (RAF), *Pseudomonas aeruginosa* (PA) and TC, 4.51%, 3.11%, 0% and 0.22% of the samples exceeded the WHO limits for TAMF, TC, FC and FS, respectively, as shown in Table 3.

Table 3. Microbiological quality of water for care standards samples in ISH during 2013-2014

Parameters	Units	Concentrations	A	B	C
RAF	CFU/100 ml	5.15	38	22	57.89%
PA	CFU/100 ml	3.55	38	8	21.05%
TC	CFU/100 ml	0	38	10	26.31%

A*: total number of sampling point;* ***B****: number of sampling points non-compliant;* ***C****: rate at not conformity*

Total aerobic bacterial counts in water samples ranged from 0 to 5.15 CFU/100ml. Indeed, lower mean CF concentrations (0 CFU/100ml) were detected in drinking water. But higher mean TAMF concentrations (5.15 CFU/ml) were obtained in drinking water of the ISH (Table 1).

For all samples, Non-compliant NC (water for care standards) = total number of non-compliant samples/total number of the samples= 0.368 (36.84%).

3.4. Water microbiologically controlled

Out of 13 water samples from water microbiologically controlled analyzed in ISH for Revivifiable aerobic flora (RAF) and *Pseudomonas aeruginosa* (PA), 4.51%, 3.11%, 0% and 0.22% of the samples exceeded the WHO limits for TAMF, TC, FC and FS, respectively, as shown in Table 4.

Table 4. Microbiological quality of water for water microbiologically controlled in ISH during 2013-2014

Parameters	Units	Concentrations	A	B	C
RAF	CFU/100 ml	778.23	13	8	61.53%
PA	CFU/100 ml	3.84	13	2	15.38%

***A**: total number of sampling point; **B**: number of sampling points non-compliant; **C**: rate at not conformity*

Total aerobic bacterial counts in water microbiologically controlled ranged from 4.16 to 778.23 CFU/100ml. Indeed, lower mean PA concentrations (3.84 CFU/100ml) were detected in water microbiologically controlled. But higher mean RAF concentrations (838.08 CFU/ml) were obtained in water microbiologically controlled of the ISH (Table 1).

For all samples, Non-compliant NC (water microbiologically controlled) = total number of non-compliant samples/total number of the samples= 0.153 (15.38%).

3.5. Water for hemodialysis

Out of 9 water samples from water for hemodialysis collected at the station of the treatment (I) analyzed and in the hemodialysis station (II) in ISH for Revivifiable aerobic flora (RAF), 4.51%, 3.11%, 0% and 0.22% of the samples exceeded the WHO limits for TAMF, TC, FC and FS, respectively, as shown in Table 5.

Table 5. Microbiological quality of water for care standards samples in ISH during 2013-2014

Parameters		Units	Concentrations	A	B	C
RAF	I	CFU/100 ml	$22.20\ 10^{5}$	9	5	55.55%
	II	CFU/100 ml	5.5	9	3	33.33%

***A**: total number of sampling point; **B**: number of sampling points non-compliant; **C**: rate at not conformity*

The highest concentration levels of the RAF analyzed were found in the water for hemodialysis collected at the station of the treatment, due to fact that this station was polluted by toxic waste water. But the lowest concentration levels of the RAF analyzed were found the hemodialysis station.

The Non-compliant NC (water for hemodialysis) = total number of non-compliant samples/total number of the samples= 0.333 (33.33%).

DISCUSSION

98 water samples from different stations tested in ISH for different bacterial as soon as TAMF, TC, FC, FS, RAF and PA. While **RAF** levels (22.2010^{5} UFC/100ml) were relatively high in water for hemodialysis as compared to the concentration found in the water microbiologically controlled (838.08 UFC/100ml) and water for care standards (3.15 UFC/100ml).

It appears from the results that the contamination of the waters samples in the ISH by different bacterial as soon as TAMF, TC, FC, FS, RAF and PA vary from one station to another and one water samples to another.

4.1. Drinking water

Microbial contamination of drinking water has long been recognized as a source of acute gastrointestinal illness [28].

TC are among the parameters considered to be indicators of water quality; given that some species of TC are of environmental confirmed origin, the health risk associated with the occasional presence of these microorganisms in the water is assessed, case by case, by the local health authority [29].

Works done by Sacchettia *et al.* [29] had shown TC levels (0.24 Log10 CFU/100 ml) similar to those in our study (0.26 CFU/100 ml). TC counts in drinking water samples in our study ranged from 0 CFU/100 ml. But FC was not detected in the samples examined. Lower values of FC (0 CFU/100 ml) were recorded in our study in 2015-2016 when compared with previous studies. In Eastern Massachusetts hospital, mean concentrations of FC (1.47 CFU/100 ml) of Drinking water were higher [28].

4.2. Water for care standards

PA was found to have the highest concentration of all the monitored bacterial in ISH. PA concentrations obtained in water for care standards similar to those of the water microbiologically controlled were found in the same site. But in the water samples in our study, the PA contents measured in Water for care standards and

Water microbiologically controlled were considerably higher than those previously reported in microfiltered water dispensers in Italy [29]. Indeed, the mean concentrations of PA in Municipal tap water, Still unchilled water, Still chilled water and Carbonated chilled was 0.30, 2.04, 1.43 and 0.62 Log10 CFU/250 ml; respectively).

The greater frequency and higher concentrations of PA detected in the dispensed water as opposed to the input water, confirm the microorganism's ability to colonize the circuits of MWDs [29].

It is well known that PA naturally present in the environment may be the source of disease in vulnerable subpopulations (the elderly or the very young, immunocompromised patients) [30; 31].

4.3. Water microbiologically controlled

PA is one of many micro-organisms that can act as an opportunistic pathogen and colonize and infect vulnerable patients. Hospital water is a recognized source *P. aeruginosa*. Several outbreaks, including the incidents involving babies in Northern Ireland in 2011/12, have been attributed to contaminated water systems [32; 33].

4.4. Water for hemodialysis

One source of pollution is the wastewater from hemodialysis. The process of waste water treatment is inefficient in inhibition and removal of pathogenic bacteria resistant to antibiotics in this wastewater [34]. That is why it was founded the Revivifiable aerobic flora (RAF) in water of the hemodialysis collected at the station of the treatment and in water of the hemodialysis station in ISH. Aerobic bacteria for example yeast and mold are capable to form colonies in culture medium nutrient agar. It is a good indicator of the overall hygienic quality of the network.

It should be noted that the mean content microbiological in drinking water did not exceeded the standard of the SML. But, the mean concentrations PA and RAF in water for care standards, water microbiologically controlled and Water for hemodialysis exceeded the Allowable average values (Table 6).

Table 6. Criteria and limits of bacteriological quality of water in all study samples

	Microbiological parameters		Present study	Allowable average values	Reference
Drinking water	TAMF		0	0/100 mL	[35]
	TC		0	0/100 mL	[35]
	FC		0	0/100 mL	[35]
	FS		0	0/100 mL	[35]
Water for care standards	RAF		5.15	≤ 100 UFC/ml	[36]
	PA		3.55	<1 UFC/100 ml	[36]
	TC		0	<1 UFC/100 ml	[36]
Water microbiologically controlled	RAF		778.23	≤1 UFC/100 ml*	[37]
	PA		3.84	<1 UFC/100 ml*	[37]
Water for hemodialysis	RAF	I	$22.20\ 10^5$	< 100 UFC/ml	[36]
		II	5.5		[36]

*: *Target level*

CONCLUSION

Drinking water was also contaminated with coliform bacteria. In addition, the data collected during the questionnaire survey indicated that the residents of study area suffered with numerous health problems. Improper disposal of solid waste, sludge and sewage have contaminated the drinking water of the study hospital with the selected anions and heavy metals.

In the study hospital, human are responsible for collection and management of water, therefore, they should be educated with water knowledge needed for sustainable use and management of drinking water.

The key reasons identified behind this non-compliance include: The contamination of water by domestic and industrial wastewater, which flows openly in many parts of ISH, the poor conditions of the water network, allowing diffusion of polluted water into it, especially when negative pressure develops inside the pipes, the insufficient disinfection of water in the network and the manual and non-hygienic handling and distribution methods of the desalinated water.

This situation has resulted in a threat to public health and the spread of water-borne diseases.

So finally to better understand the quantitative and qualitative fluctuations in the bacterial diversity found in this hospital, further studies by means of the molecular biology of resistance of these organisms must be deeper.

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