MONITORING OF THE MICROBIOLOGICAL QUALITY OF WATER THAT PROVIDES HOSPITALS OF MUNICIPALITIES OF MARANHÃO STATE FROM ALTERNATIVE SOURCE OR NOT

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ABSTRACT

The purpose of this study is to evaluate the microbiological quality of water that supplies public hospitals in Maranhão State - Brazil and its capital, considering the serious problem related to the lack of water quality for a significant part of the health units of the state. During the third quarter of 2015, water samples were analyzed from hospitals, totaling 22 health units using the suggested methodology by the book "Standard Methods for Examination of Water and Wastewater". Thus, the article aims to present to the society and public authorities the water quality in Health Units of the State.

INTRODUCTION

The water quality became a matter of public health concern in the late 19th and early 20th centuries. Prior to that, quality was associated only with aesthetic and sensory aspects such as color, taste and odor. Methods for improving the aesthetic and sensory aspects of water have already been found 4,000 years ago in documents written in Sanskrit. However, in ancient Greece, they used techniques such as filtration, sun exposure and boiling to improve water quality.

The Greeks, motivated more by the turbid appearance of water, empirically noted the existence of causal relationships between water and disease, as did Hippocrates (Usepa, 1999).

In the mid-19th century, advances were made in understanding the relationship between contaminated water and disease. It highlights the work of epidemiologist John Snow, who in 1855 proved that a cholera outbreak in London was associated with sewage-contaminated public wells.

Later on, in 1880, Louis Paster demonstrated that microscopic organisms (microbes) could transmit disease through water. At the same time, scientists discovered that the turbidity was not only related to aesthetic aspects. The particulate material in water could contain pathogenic organisms and fecal material.

At the beginning of the 20th century, due to scientific discoveries, many water treatment systems were built in the United States, using a slow filtering as a strategy to control water quality. Years later, a phrase first employed in the State of New Jersey in 1908.

In Europe, at the same time, other disinfectants are also used, such as ozone. The initiatives for the potable water treatment of human consumption occurred prior to the establishment of quality standards. Some pioneering initiatives deserve special mention. In 1914, a US federal standard, developed by the public health service at the time, set a standard for microbiological quality of water.

However, this standard was applied only to water produced by the supply system and transported via ships and trains to other states, and was limited to contaminants capable of causing contagious diseases (Usepa, 1999).

Maximum permissible values or maximum contamination limits (MCLs) were established based on toxicological studies and bioassays, chemical and physicochemical components capable of altering the sensory properties of water, which, in addition to causing consumption rejection, they can stimulate conditions conducive to the reduction of the useful life of the whole hydraulic apparatus with consequent economic losses.

Currently, the World Health Organization (WHO) is the institution that follows and recommends the maximum values allowed of the toxicological studies carried out around the world, and published in different magazines and scientific events specialized in the theme.

In some countries, such as the United States, Canada, and the European Community, while also relying on WHO recommendations, encourage toxicological surveys and bioassays that, in turn, serve as a reference for both WHO and other countries. All potability standards in Brazil follow basically the recommended standards by the World Health Organization in the Guidelines for Drinking Water Quality (WHO, 1996).

Despite having a potability standard since 1977, water quality monitoring for human consumption was only implemented in Brazil as a program, since the creation of the National Health System of Environmental Surveillance (Funasa, 2002).

This program is structured as a subsystem, and has as one of its responsibilities the coordination of an information system for monitoring and controlling the quality of water for human consumption (Sisagua).

The information that has been feeding the database has to do with physical-chemical, chemical and microbiological aspects, and data on the quality, flow, population supplied and the location of the system.

Sisagua has been fed with information generated by those responsible for the operation of water supply systems (microbiological, chemical and physical data monitoring obtained in the water quality control), and responsible for the water quality monitoring, in this case, the State and Municipal Health Secretariats.

The participation of different social actors as active subjects in the elaboration, formulation, execution and evaluation of water quality for human consumption is fundamental to overcome this current and hegemonic surveillance model. A fundamental step for this is the provision of information on the water quality for the expansion of community participation, in the search for a participative management that displaces decision-making, aiming at social control.

The data systematization about the water quality must be shared. Breaches of potability standards must be clear, for the public authorities, companies and society, so that the potability parameters contained in Administrative Rule 2914/11 MS can be effectively complied with.

The lack of basic sanitation or the inefficiency of the provision of these services contributes strongly to the precarious public health of a locality. This is evidenced in Brazil by observing the quality of most urban water, the quality of life of the citizen, and the high level of susceptibility of the population to waterborne diseases, which according to the National Health Foundation (FUNASA, 2010) are classified as Diseases Related to Inadequate Environmental Sanitation, or simply DRSAI.

The research is based on the need to evaluate the water quality to be consumed in the Health Units, since water is a source of life, and can also be a transmission channel for many diseases (Brazil, 2006). The most common diseases that occur in the population, caused by the ingestion of low quality water and purity are cholera, typhoid fever, dysenteries, and diseases that can be caused by simple contact, such as scabies and trachoma. The major diseases associated with water are caused by bacteria and viruses. These microorganisms are not usually found in the aquatic environment and their presence is mainly related to the contamination by feces of infected humans (Ferreira *et al.*, 2016).

The lack of basic sanitation or the inefficient provision of these services strongly contributes to the precarious public health of any locality. This is evidenced in Brazil by observing the quality of most urban water, the quality of life of the citizen, and the high level of susceptibility of the population to waterborne diseases, which according to the National Health Foundation (FUNASA, 2010) are classified as Diseases Related to Inadequate Environmental Sanitation, or simply DRSAI.

Thus, the possibility of existence of these pathogenic microorganisms in the water is indirectly determined by the analysis of total coliforms and *Escherichia coli*. These bacteria exist in great quantity in the human intestine and are eliminated by the feces. Thus, bacteria from the coliform group are indicative of water contamination by pathogens (BRASIL, 2006).

Water for urban water supply, a source of disease transmission. To ensure water potability, municipal water treatment plants are essential to avoid contamination and disease spread. Before reaching human consumption, water may contain impurities and physical, chemical and microbiological characteristics that differ from the standards delimited by public health agencies. Therefore, it must undergo a treatment process until reaching the suitable levels for human consumption. (Rodrigues et al., 2016).

All water intended for human consumption from individual alternative solution of water supply is subject to quality monitoring. The water for human consumption is the drinkable water intended for ingestion, preparation and food production, and personal hygiene, regardless of its origin. The water quality control for human consumption is composed of a set of activities carried out regularly by the person in charge of the water supply system, to verify if the water supplied is potable, in order to ensure the maintenance of this condition (MINISTÉRIO DA SAÚDE, 2004).

In view of the above, it's proposed to ensure the procedure quality of quality control, monitoring the validity of the tests performed, so that the water consumed is in compliance with the microbiological standard, as provided in Annex I and other provisions of Ordinance 2914/11 MS.

METHODOLOGY

A total of 66 water samples were collected, during the period of three months in 2015, in 22 hospitals in the cities of Maranhão State, including the capital. All samples were collected in the dining rooms or kitchen.

Samples were collected in 200 ml sterile plastic bottles containing 0.2 ml of 10% sodium thiosulfate solution to neutralize the action of the residual chlorine. The water was flowed for 2 to 3 minutes, so that the entire liquid column of the pipe was eliminated. At the time of collect, the tap was opened so as to obtain a small flow of water to avoid spilling out of the collect flask, which was positioned vertically. Each sample was homogenized, and then packed, and transported in Styrofoam with ice and kept at 4 to 8ºC, and taken to the Clinical Microbiology Laboratory of the Federal University of Maranhão, where they were analyzed within 24 hours. Throughout the procedure the flame of the Bunsen burner was lit for aseptic handling of the samples. It was transported in Styrofoam on ice and held at 4 to 8 °C, and analyzed within 24 hours.

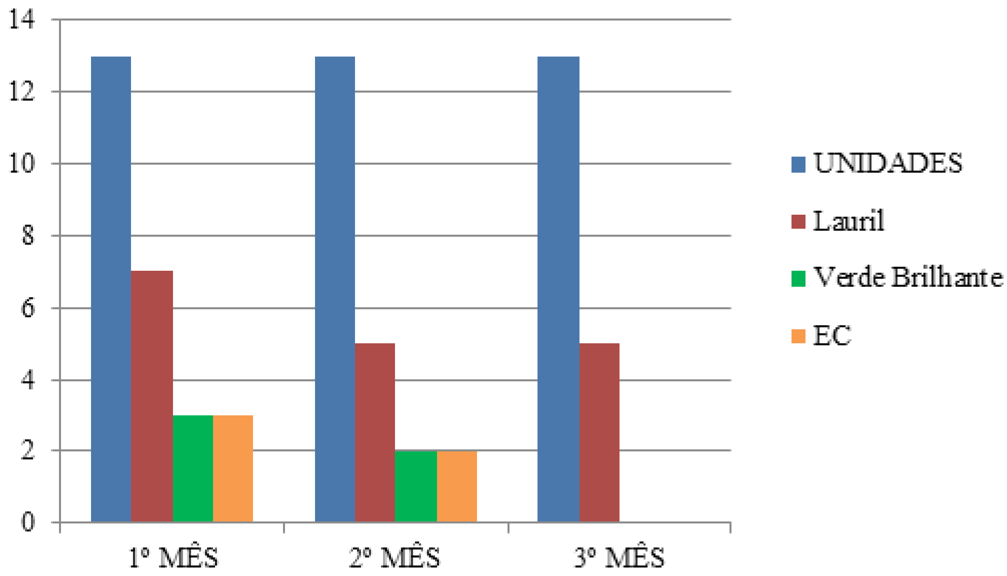
The methodology used for water quality analysis was through the test of Presence/Absence in 100 mL in Lauryl Broth (LB), whose, in the presence of growth is taken 1mL of the (LSB) to Brilliant Green Broth (BG) and Escherichia coli broth (EC) for analysis of presence/absence of total and thermotolerant coliforms, which is a methodology used as a standard, since it is widely recommended by Sanitary Surveillance, and other regulatory agencies. It was also carried out the Colony Forming Units (UFC) counting, using Plate Count Agar (PCA), following the recommendations of the Standard Methods For Examination Of Water And Wastewater (2012).

RESULTS

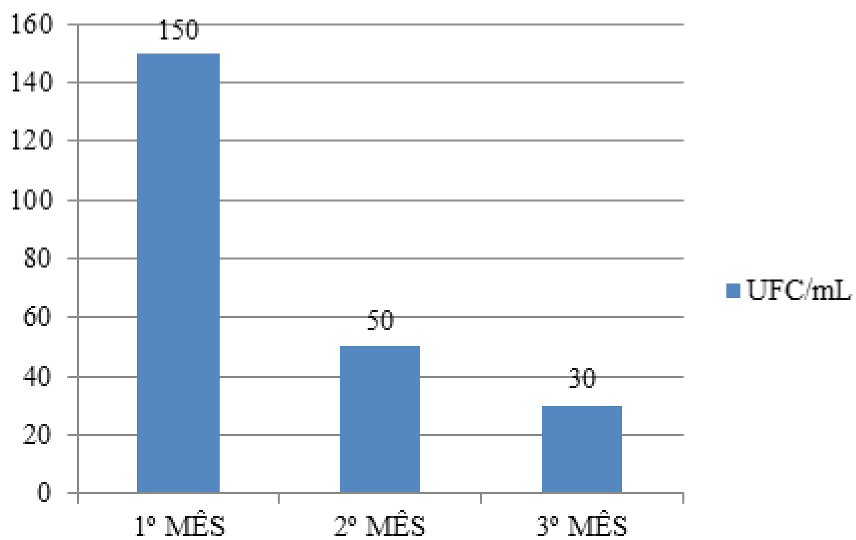
During the period of three months that was followed the water quality, in 22 hospitals of Maranhão State, 66 samples were analyzed, using the following culture medium: Lauryl, Brilliant Green (BG), Escherichia coli Broth (EC), and Plate Count Agar (PCA)**.**

In the capital, it was possible to observe a clear evolution in the microbiological water quality, since at the beginning of the work, 3 positive samples for *E. coli* were identified, and at the end, there were no positive sample in the EC medium nor in the BG.

Regarding to the count of heterotrophic bacteria, made on the PCA medium, it was also verified a significant improvement, due the Colony Forming Unity (CFU x mL-1) to presented from 150 CFU / mL in the first month to 30 CFU / mL in the latter, as shown in the graphs below.

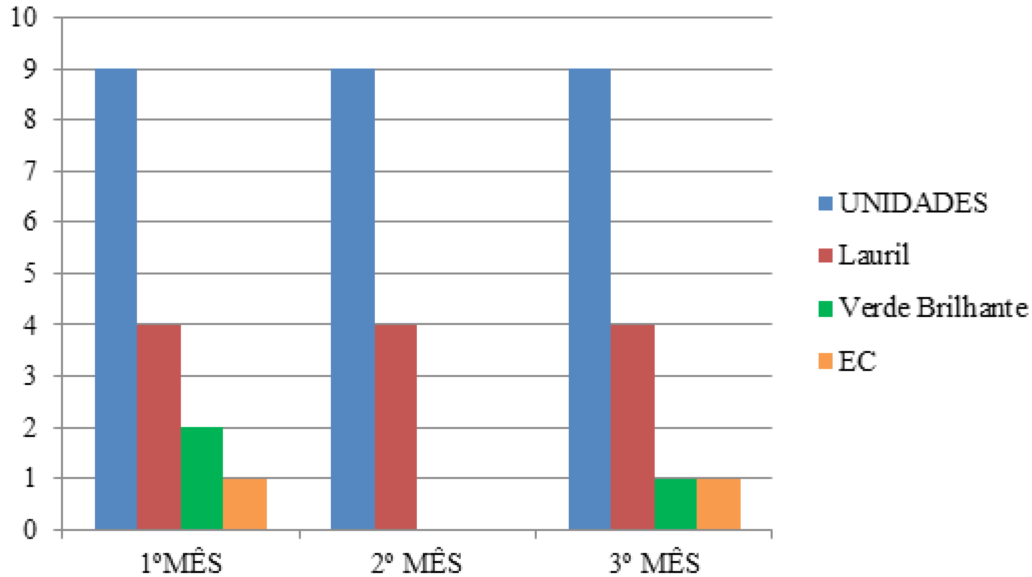


Graph 1 - Evolution of water treatment at the capital of Maranhão in relation to positivity in the culture medium used in the tests. **Source**: Author (2016)

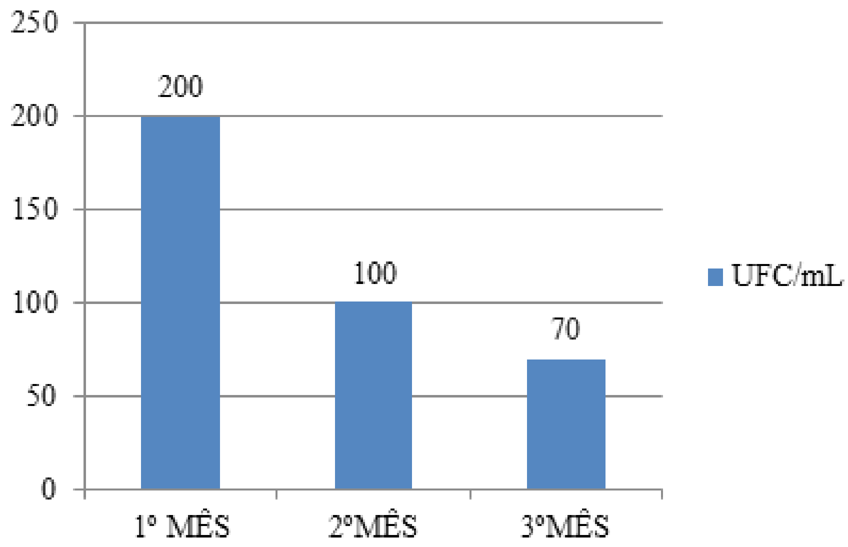


Graph 2 - Evolution of water treatment at the capital of Maranhão in relation to the number of Colony Forming Units per mL of water (CFU / mL). **Source**: Author (2016)

It was 9 units from countryside cities, that only one was thermotolerant coliform positive in the first month. In the second month, all samples were negative. In the third month, it was observed that only one sample was thermotolerant coliforms positive. This one came from another health unity, different from that one that was positive in the first moment. As for CFU, a gradual improvement in their average was observed, from 200 to 70 in just three months.



Graph 3 – Evolution of water treatment in the interior of Maranhão in relation to positivity in the culture medium used in the tests. **Source**: Author (2016)



Graph 4 – Evolution of water treatment in the interior of Maranhão in relation to the number of Colony Forming Units per mL of water (CFU / mL). **Source**: Author (2016)

DISCUSSION

Although the state of Maranhão has the water supply primarily provided by the Water Supply System (SSA), It doesn't mean that the population has treated water, where the percentage of people supplied by untreated SSA is twice that of the region average North East of the country. Maranhão has a high rate of Hepatitis A, that along with other factors, may be related to the low coverage of water supply services through general network and sanitary sewage. In order to verify if the water conforms to the drinking standard established by the legislation, it is necessary to use as an instrument, the water quality monitoring, in order to evaluate the quality over time, as well as the treatment efficiency and integrity of the distribution system (Ministério da Saúde, 2012).

Throughout the study, it was observed the microbiological water quality that supplies all 22 health units and hospitals spread around Maranhão State.

The results from the capital have shown that the addition of chlorine in the reservoirs is capable of eliminating the contamination in the water distribution system.

The results from the countryside units have revealed the need of constant and rigorous monitoring of the addition of chlorine and other monitoring, that must be taken in order to avoid water contamination, since in the first month of the study, a contaminated sample was verified, and in the second month none, evidencing the effectiveness of chlorine decontamination.

In the third month, a sample that had never been positive, was verified with contamination by thermotolerant coliforms, which indicates recent external contamination and insufficient chlorination.

This leads to a careful analysis of the entire water distribution system in order to identify the possible entry for contamination. Thus, it must be done inspections on all pipes looking for leaks, constant checking of cisterns lids or water tank, and analyze the chloride concentration, because the presence of total coliforms and *Escherichia coli* is indicative of water contamination provided by these health units, and it compromise directly its potability.

Another vigilance to be taken is the microbiological water analysis from an alternative source, before it enters in the reservoirs to be chlorinated, that is, soon after leaving the well. In this way, the water quality of the water table can be evaluated in order to find out if It is contaminated or not.

The determination of heterotrophic bacteria should be performed as one of the parameters to evaluate the integrity of the distribution system (reservoir and network), and it is recommended not to exceed the 500 CFU / mL limit (Saúde, 2011).

Although the samples haven't present results higher than 200 CFU/mL, there was a significant difference in the reduction of the contamination of samples from capital and countryside after the adequate water treatment.

The reproof of water samples for human consumption is very common, and it may be due to the lack of inspection or inadequate maintenance of water reservoirs, as can be seen in the survey of studies on the subject. Coelho et al. (2007) verified that, in 45 samples of mineral water commercialized in supermarkets in the city of Alfenas, MG, 26 samples were improper for human consumption in relation to heterotrophic bacteria, and could present a risk to consumer health.

Carvalho et al. (2009) analyzed samples from the campus of the city of Ipatinga, Minas Gerais, during the sampling cycle, which were free of total coliforms (mean MPN <1.1 / 100 mL), that is, suitable for human consumption, and in subsequent collect, the water samples presented contamination by coliforms, being classified as improper for human consumption, since the legislation claims that all samples should have absence of total coliforms. One collect presented mean above NMP <1.1 / 100 mL. This contamination may be due to the greater use of analyzed drinking fountains, and can be contaminated by people when using them.

Brilhante et al. (2011) collected a water simple from the entrance and water from drinking fountains in the two schools of Coremas-PB in April 2015. In general, the parameters analyzed in the samples of these two schools are unsatisfactory for human consumption. The presence of total coliforms and *Escherichia coli* is indicative of water contamination provided by these schools, directly compromising its potability.

In a study conducted by Santos (2016), water from a company in the municipality of Currais Novos / RN, which works as a collective alternative solution for the supply of water for human consumption, has a collective supply system to provide potable water with underground abstraction, with channelization and without distribution network, for these analyzes was used the Method of the Most Probable Number. This methodology does not allow to assert the absence of microorganisms, however, it is possible to estimate the amount of microorganisms per 100mL of sample.

The results found in the analyzes were <1.1 NPM / 100 mL, this is the smallest possible result to find with the methodology used, where in this result range, there is the possibility of absence of Total Coliforms and *E. coli*. These results are due to the use of chlorine dioxide, an oxidizing compound that is gaining market due to its high oxidizing power compared to the sodium hypochlorite used by the treatment plants.

Thus, there's need for continuing the water quality monitoring in health institutions, where there is a great flow of people. Mainly in collective drinking fountains, because they are exposed in dining rooms and kitchens, therefore, having a great risk of contamination.

CONCLUSION

At the conclusion of this article, it’s necessary to affirm that the mere presence of total coliforms in a sample of water for consumption is sufficient for its failure, without the need to obtain positivity in the research for thermotolerant coliforms, as regulated by Ordinance Nº 518/04 of the Ministry of Health, and following the results obtained by the NMP/100 mL Method (MINISTÉRIO DA SAÚDE, 2004). In this case, it was observed the presence of thermotolerant coliforms what make the results unsatisfactory with the presence of *E. coli*, the main bioindicator of fecal waste. Consumption water from these institutions without adequate treatment may expose the community to health risks through waterborne diseases. This allowed us to understand the importance of water treatment and the testing of presence and absence of total coliforms and *E. coli,* which should be applied in water treatment plants and public agencies, especially health institutions. Therefore, a systematic follow-up is necessary to maintain hygiene and microbiological control in the water reservoirs of these establishments.

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