

Evaluation of Drinking Water Quality in Hospitals: A Study from Ranchi, Jharkhand, India

ABSTRACT

Water is one of the natural resources, which are found in an adequate amount. It is an essential source for the existence of life on the planet earth. Water plays an important role in our health. It helps in bringing nutrient to cells, getting rid of wastes, protecting joints and organs and maintaining our body temperatures. Water supply to healthcare facilities is frequently an overlooked yet essential for safe patient care and can be manageable source of infections. This paper presents a study in drinking water quality of different hospitals in which 8 water samples from three government hospitals and five private hospitals were collected in Ranchi district (total 8) and were analyzed for 10 physio – chemical parameters such as pH, Electrical conductivity, Temperature, Alkalinity, Chloride, Total hardness, Calcium hardness, Magnesium hardness, Turbidity and Total dissolved solids. All the water samples were within the permissible limits stated by both BIS and WHO.

Keywords: Drinking water quality, Hospital water, physio-chemical parameters, Ranchi.

1. INTRODUCTION

“Water is one of the natural resources, which are found in an adequate amount. It is widely used for various purposes such as drinking, washing, bathing, cleaning, cooking, irrigation, and other industrial and domestic uses”. (Miller, 1997)¹. “In hospitals, water is utilized for many things, such as cleaning, personal hygiene, prescription administration, central sterilizing techniques, laboratory water treatment systems, and dialysis. Hospitals use an average of 1litres of water per room per day, more than schools and workplaces but less than hotels and elderly care facilities. Hospitals are among the most water-intensive buildings”. (Khadim, 2023)².

“Drinking water quality is a global issue, with contaminated unimproved water sources and inadequate sanitation practices causing human diseases. It should meet physicochemical pollutants criteria and be entirely free of pathogens that could harm people’s health”(Addisie, 2022)³. “Water supply to healthcare facilities is frequently an overlooked yet essential for safe patient care and can be manageable source of infections. Numerous healthcare-associated (HAI) outbreaks have been linked to contaminated water used for patient care particularly maternal and child health, hand washing, and cleaning of medical devices for reprocessing to name but a few. Good quality potable water is still an unmet need in many low- to middle-income countries”. (Mehtar, April 2018)⁴.

“Water, sanitation and hygiene are critical elements that contribute to safety and quality in healthcare settings. Effective WASH practices are essential for preventing healthcare-associated infections, which pose a significant risk in hospitals, clinics and other medical facilities. The lack of clean water and sanitation facilities can severely impede the ability of healthcare workers to perform their duties effectively, thus compromising patient care. Furthermore, improving facilities in healthcare settings is not only about enhancing patient care but is also about protecting healthcare workers. These professionals are at the frontline of disease exposure, and without adequate protective measures and sanitation facilities, their health and ability to work are jeopardized”(Gnanasekaran, 2024)⁵.

2. MATERIALS AND METHODS

The present study “**Evaluation of Drinking Water Quality in Hospitals: A Study from Ranchi, Jharkhand**” was carried out in Ranchi. The details are as follows.

2.1 Sampling Area

Ranchi is the capital of the Indian State of Jharkhand. It was formed on 15 November 2000 by carving out the Bihar divisions Ranchi lies at 23°22'N 85°20'E near to the Tropic of Cancer. The city covers an area of 175 km² (68 sq. mi) and its average elevation is 651 m above sea level.

2.2 Collection and Preservation of Samples

Water samples were collected during the month of January 2024 to May 2024 (5 months), from 8 different hospitals of Ranchi district. The samples were collected in morning as well as evening hours between 8:00 am to 4:00 pm in clean air tight bottles without any contamination. The bottles were first rinsed thoroughly with sample water and then water sample was collected. After that, they were properly labelled according to its respective location notations and were further taken to the laboratory for analysis.

2.3 Sampling frequency

Samples were collected and analyzed in every 30 days of interval during monitoring period.

2.4 Analysis of Collected Samples

After the collection of water samples, the experimental analysis was conducted in Biocrat Environmental Services Laboratory, Ranchi. The analysis was done by using standard methods. The parameters analyzed areas pH, Electrical conductivity, Temperature, Alkalinity, Chloride, Total hardness, Calcium hardness, Magnesium hardness, Turbidity and Total dissolved solids.

2.5 Sampling Sites

The water samples were collected from the selected hospitals for assessing the water quality for drinking purpose.

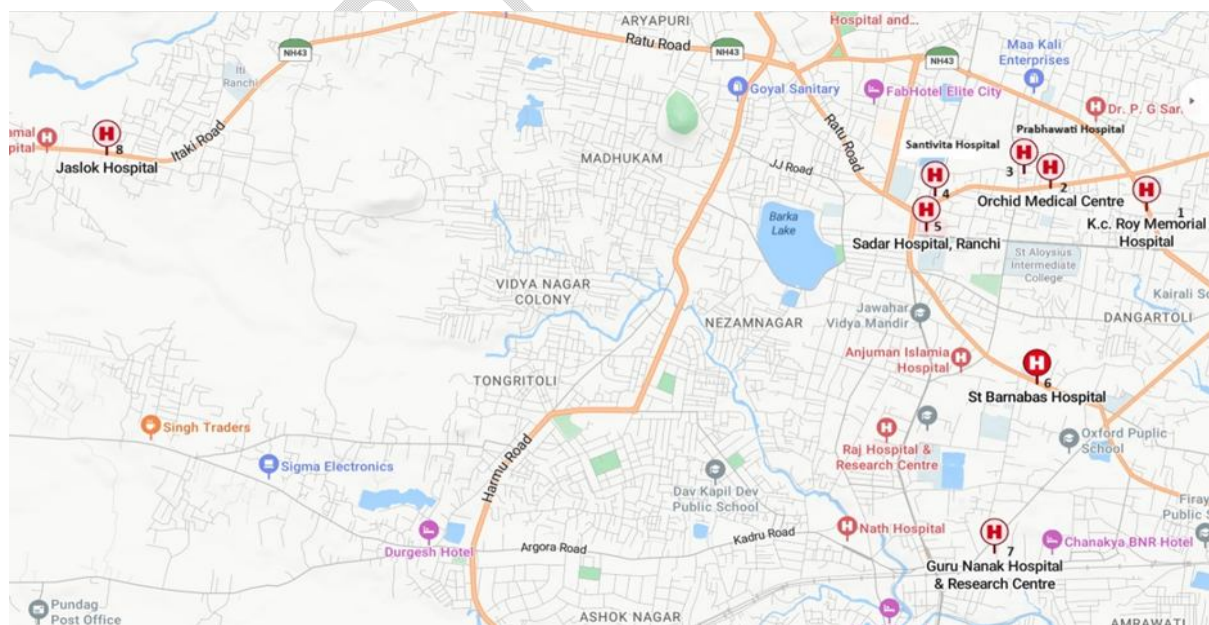


Figure 1. study area

2.6 Hospitals

H₁ = KC Roy Memorial Hospital (**Government Hospital**)

H₂ = Orchid Hospital (**Private Hospital**)

H₃ = Prabhawati Hospital (**Private Hospital**)

H₄ = Santevita Hospital (**Private Hospital**)

H₅ = Sadar Hospital (**Government Hospital**)

H₆ = Barnabas Hospital (**Government Hospital**)

H₇ = Guru Nanak Hospital (**Private Hospital**)

H₈ = Jaslok Hospital (**Private Hospital**)

2.7 Parameters Analyzed

Different parameters, signifying the quality of water at different sites were analysed by following methods.

2.8 Physico-Chemical Parameters of Water

Table 1: BIS (IS: 10500:2012), Standard for drinking water

SL.NO	Parameters	Desirable limits	Permissible Limits
1	pH	6.5-8.5	No relaxation
2	E.C (µs/cm)	100 (µs/cm)	2000 (µs/cm)
3	Temperature (°C)	-	-
4	Alkalinity (mg/l)	200 mg/l	600 mg/l
5	Chloride (mg/l)	250 mg/l	1000 mg/l
6	Total Hardness (mg/l)	200 mg/l	600 mg/l
7	Calcium Hardness (mg/l)	75 mg/l	200 mg/l
8	Magnesium Hardness (mg/l)	30 mg/l	100 mg/l
9	Total Dissolve Solids (mg/l)	500 mg/l	2000 mg/l
10	Turbidity (NTU)	1 NTU	5 NTU

Table 2: WHO Standards for drinking water

SL.NO	Parameters	Desirable limits	Permissible Limits
1	pH	7.0-8.5	6.5-9.2
2	E.C ($\mu\text{s}/\text{cm}$)	150 ($\mu\text{s}/\text{cm}$)	2700 ($\mu\text{s}/\text{cm}$)
3	Temperature ($^{\circ}\text{C}$)	-	-
4	Alkalinity (mg/l)	200 mg/l	600 mg/l
5	Chloride (mg/l)	200 mg/l	600 mg/l
6	Total Hardness (mg/l)	100 mg/l	500 mg/l
7	Calcium Hardness (mg/l)	75 mg/l	200 mg/l
8	Magnesium Hardness (mg/l)	30 mg/l	100 mg/l
9	Total Dissolve Solids (mg/l)	500 mg/l	1000 mg/l
10	Turbidity (NTU)	1 NTU	5 NTU

3. Results and Discussion

pH:The maximum pH 7.24 was observed in H₅(Sadar Hospital) and the minimum pH 6.57 was observed in H₁(KC Roy Hospital). The safe range for drinking water pH levels is between 6.5 and 8.5. Water quality with high acidic and alkaline conditions have distinct effects on various water quality parameters. **Water with a very low or high pH can be a sign of chemical or heavy metal pollution. When pH in drinking water is greater than 8.5, it can make the water taste bitter and contact with high pH can cause skin irritation whereas alkaline water neutralize acid in patients' bloodstream. (Dewangan, 2023)⁶**

Electrical Conductivity:The maximum EC 1.12 $\mu\text{s}/\text{cm}$ was observed in H₁ (KC Roy Hospital) and the minimum EC 0.23 $\mu\text{s}/\text{cm}$ was observed in H₇(Gurunanak Hospital). Conductivity measures water's ability to conduct electricity and indicates dissolved ionic solid concentration and salinity. High conductivity can cause corrosion, scale build-up, mineral-like taste in drinking water, and issues with dissolved solid concentration in agriculture. **(Xianhong, 2021)⁷**

Temperature:The maximum temperature 30.2 $^{\circ}\text{C}$ was observed in H₆ (Barnanas Hospital) and the minimum temperature 23.4 $^{\circ}\text{C}$ was observed in H₅(Sadar Hospital). Drinking water temperature can significantly increase or decrease during distribution from the source to the consumer. This change is strongly influenced by the weather, the depth of installation of transport and distribution pipes, the soil type, ground water levels, presence of anthropogenic heat sources and hydraulic residence times. At the

building level, drinking water temperature can also be affected by the layout of the hot water installations. (Agudelo, 2020)⁸

Alkalinity: The maximum Alkalinity 82.4 mg/l was observed in H₅(Sadar Hospital) and the minimum alkalinity 31.2mg/l was observed in H₇(Gurunanak Hospital). Alkalinity in water means presence of ions. It also indicates that the potential of hydrogen value of water is good. It has small clusters of water molecules and is good for health. (Lal et al, 2022)⁹. Its potential to prevent chronic health conditions and improve menopause symptoms. (Goldman, 2024)¹⁰

Chloride: The maximum chloride 93.4 mg/was observed in H₃(Prabhawati Hospital) I and the minimum chloride 14.2 mg/l was observed in H₇(Gurunanak Hospital). In drinking or potable water, water containing 250 mg/l of chloride may have a salty taste if the chloride came from sodium chloride. (Khateeb, 2014)¹¹. When chlorine is mixed with organic compound that are found in water they produce harmful by-products producing free radicals which trigger cell damage in our body. Boiling of water or investing in a good water filter can help in reducing chlorine from water.(Robbins, 2020)¹²

Total Hardness: The maximum hardness 353 mg/l was observed in H₁ (KC Roy Hospital) and the minimum hardness 128 mg/l was observed H₇(Gurunanak Hospital). The hardness in water is caused by polyvalent metallic ions from sedimentary rocks, seepage and runoff from soils. Calcium and magnesium are the two main ions causing hardness in water. (Rehman et al, 2018)¹³. There is no serious health effects associated with drinking hard water. However solid water acts as a dietary supplement as it contains calcium and magnesium that strengthens bones and teeth and acts as protective factors against cardiovascular diseases. Consumption of hard water can give a dry skin and hair. (Dubey, 2022)¹⁴

Calcium Hardness:The maximum calcium hardness 95.8 mg/l was observed in H₁(KC Roy Hospital) and the minimum calcium hardness 26.4 mg/l. was found in H₇(Gurunanak Hospital) Drinking water with high concentration of calcium has been associated with a lower risk of cardiovascular mortality in ecological and case control studies. (Emilie et al, 2022)¹⁵

Magnesium Hardness: The maximum Mg hardness 33.8 mg/l was observed in H₁(KC Roy Hospital) and the minimum Mg hardness 3.4 mg/l was observed in H₇(Gurunanak Hospital).

Turbidity:The maximum turbidity 4.47 NTU was observed in H₂ (Orchid Hospital) and the minimum turbidity 0.26 NTU was observed in H₇ (Gurunanak Hospital). Turbidity indicates the presence of pathogenic microorganisms and be an effective indicator of hazardous events throughout the water supply system, from catchment to point of use. (WHO, 2017)¹⁶. When turbidity levels rise, water becomes more difficult to treat and the risk of waterborne disease outbreaks increases. Suspended particles can provide shelter for microorganisms, making it harder for disinfectants like chlorine to effectively kill them. As a result, harmful microbes, such as protozoa, can survive even after treatment and pose a threat to public health.(Chandler,2023)¹⁷

Total Dissolved Solids:The maximum TDS 734.6 mg/l was observed in H₁ (Sadar Hospital) and the minimum TDS 155 mg/l was recorded in H₇(Gurunanak Hospital). The concentration of total dissolved solids (TDS) present in water is one of the most significant factors in giving water taste. It also provides important ions such as calcium, magnesium, potassium, and sodium. (Wang, 2021)¹⁸. High TDS levels can be associated with elevated concentrations of heavy metals like lead or arsenic, which are harmful even in small amounts. Excessive sodium or chloride levels can be problematic for individuals with hypertension or kidney conditions. (3D Aqua, 2024)¹⁹.

Table 3: Assessment of pH, EC, Temperature, Total Alkalinity and Chloride of Drinking water in Hospitals at Ranchi

Parameter →	pH	EC μs/cm	Temp. (°C)	TA (mg/l)	Cl ⁻ (mg/l)
Hospitals ↓					
KC Roy	6.578	1.1206	25.8	61.6	50.4
Orchid	6.614	1.0762	26.2	70	38.2
Prabhawati	7.074	0.8078	27.8	78	93.4
Santevita	6.728	0.7878	25.2	52	15.4
Sadar	7.234	0.5584	23.4	82.4	80
Barnabas	6.686	0.9138	30.2	40.8	52.4
Gurunanak	7.068	0.2388	28.6	31.2	14.2
Jaslok	6.734	0.9364	26.2	67.2	17

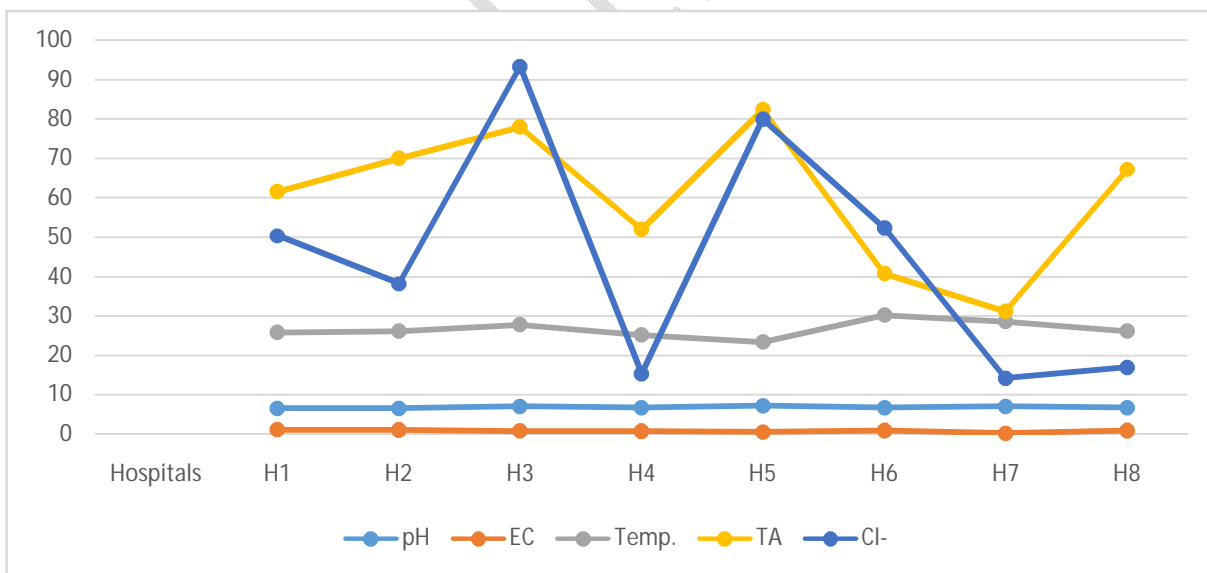


Fig 2: Assessment of pH, EC, Temperature, Total Alkalinity and Chloride of Drinking water in Hospitals at Ranchi

Table 4: Assessment of Total Hardness, Calcium Hardness, Magnesium Hardness, Turbidity and Total Dissolved Solids of Drinking Water of Hospitals at Ranchi

Parameter Hospitals	TH (mg/l)	Ca ²⁺ (mg/l)	Mg ²⁺ (mg/l)	Turbidity NTU	TDS (mg/l)
KC Roy	353.8	95.8	33.8	2.752	734.6
Orchid	316	82.6	28.4	4.476	693.4
Prabhawati	263.4	68.8	18.2	2.57	521
Santevita	222.4	58.4	20	2.602	506.2
Sadar	148.6	47.4	12.6	4.342	357.6
Barnabas	268.4	77.4	23.2	1.268	597
Gurunanak	128	26.4	3.4	0.268	155
Jaslok	290.8	88	18.2	0.804	610.2

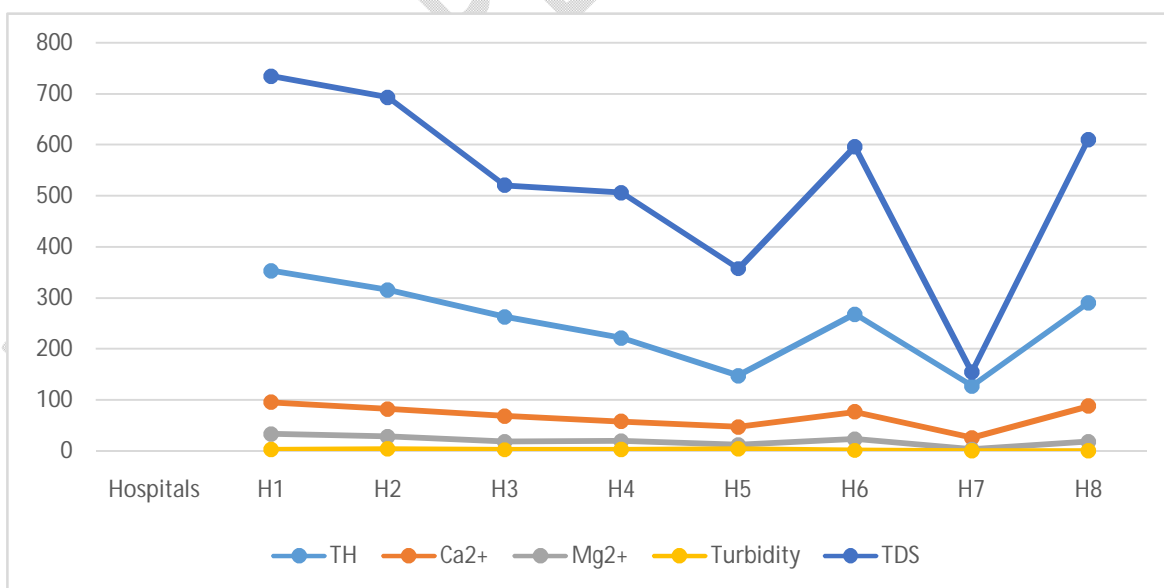


Fig 3: Assessment of Total Hardness, Calcium Hardness, Magnesium Hardness, Turbidity and Total Dissolved Solids of Drinking Water of Hospitals at Ranchi

4. CONCLUSION

The present research work assessment of drinking water quality of different hospitals in Ranchi, Jharkhand was the concern expressed for deterioration in drinking water quality. It is observed that the analyzed parameters of drinking water from 8 different hospitals at Ranchi showed that the pH, EC, Temperature, Alkalinity, Chloride, Total hardness, Ca hardness, Mg hardness, Turbidity and TDS values were all within the desirable and permissible limit as per the standards given by BIS & WHO. The water samples are fit for drinking and other purpose as well as safe for patients and the hospitals staffs.

5. Disclaimer (Artificial intelligence)

I hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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