e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(8); 736-742

Original Research Article

# Bacteriological Survey of Drinking Water Quality in a Tertiary Care Hospital of North India

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**Received: 01-05-2026 / Revised: 15-06-2026 / Accepted: 21-07-2026**

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**Conflict of interest: Nil**

**Abstract**

**Background:** Safe drinking water is essential in healthcare facilities because contaminated water may contribute to water-borne infections and healthcare-associated infections. Microbiological surveillance of hospital drinking water sources helps identify faecal contamination and guides corrective measures.

**Aim:** To assess the bacteriological quality of drinking water in a tertiary care hospital of North India.

**Materials and Methods:** This hospital-based bacteriological survey was conducted from 1 January 2024 to 31 December 2024. A total of 324 drinking water samples were collected from nine drinking water sites. Samples were collected aseptically in sterile screw-capped bottles, transported immediately to the microbiology laboratory and tested for presumptive coliform count by the multiple tube culture method using MacConkey purple broth with single-strength and double-strength media. The tubes were incubated at 37°C for 48 hours. Tubes showing colour change were further processed for organism identification as per standard microbiological protocol. Water quality was categorised using the most probable number table.

**Results:** Out of 324 drinking water samples, 249 (76.9%) were categorised as excellent, 15 (4.6%) as satisfactory, 27 (8.3%) as intermediate and 33 (10.2%) as unsatisfactory. Escherichia coli was the most common organism isolated, detected in 48 (14.8%) samples, followed by Pseudomonas species in 21 (6.5%) samples and Klebsiella species in 6 (1.9%) samples.. The maximum reported most probable number was 161.

**Conclusion:** Most drinking water samples were categorised as excellent; however, the detection of intermediate and unsatisfactory samples, along with isolation of E. coli, Pseudomonas species and Klebsiella species, indicates the need for periodic microbiological surveillance of hospital drinking water. Regular monitoring, timely corrective measures and maintenance of water-distribution systems are necessary to reduce the risk of water-borne healthcare-associated infections.

**Keywords:** Drinking Water; Coliform Bacteria; Hospital Water Quality; Most Probable Number; Escherichia Coli; Healthcare-Associated Infection.

**DOI:** 10.25258/ijcpr.18.8.113



## Introduction

Safe drinking water is a basic requirement for patient care, hospital hygiene and infection prevention. In healthcare settings, drinking water is used by patients, attendants, healthcare workers and support staff; therefore, contamination of water sources can have direct clinical and public health implications. International and national drinking water standards emphasise the absence of faecal indicator organisms in potable water because their presence suggests possible faecal contamination and unsafe water quality. [1,2]

Hospital water systems may become contaminated through unsafe source water, inadequate treatment, defective storage tanks, damaged pipelines, stagnation, biofilm formation or poor maintenance of outlets. Water-borne organisms may contribute to sporadic infections or outbreaks, particularly among vulnerable patients in intensive care units, neonatal units, postoperative wards and immunocompromised settings. [3,4] Microbiological surveillance of water sources is therefore an important component of hospital infection-control practice.

Coliform bacteria are widely used as indicators of faecal contamination. The multiple tube method with most probable number estimation remains a

recognised method for bacteriological assessment of water quality. [5,6] Several Indian studies have assessed bacteriological contamination of drinking water using MPN or coliform-based methods. Kumar et al. reported bacteriological analysis of drinking water by the MPN method in a tertiary care hospital and adjoining area of Western Uttar Pradesh, while Srivastava et al. assessed hospital and residential water supply in a tertiary care hospital of Northern India. [7,8]

Kirankumar et al. studied water samples from different points in a tertiary care hospital, and Shamsi et al. evaluated bacteriological quality of drinking water from the catchment area of a tertiary care teaching hospital. [9,10]

Other Indian studies from Amritsar, Shimla, Jammu, Jabalpur and Chennai have also reported variable bacteriological quality of drinking water from different sources, supporting the need for regular microbiological monitoring of drinking water supplies. [11-15]

The objective of this study was to assess bacteriological contamination of drinking water samples collected from multiple drinking water sites in a tertiary care hospital of North India over a one-year period.

## Materials and Methods

**Study design**: This was a hospital-based observational bacteriological survey of drinking water quality.

**Study setting**: The study was conducted in the Department of Microbiology, Hind Institute of Medical Sciences, Barabanki, and Uttar Pradesh, India.

**Study period:** The study was conducted over 12 months, from 1 January 2024 to 31 December 2024.

**Sampling sites and sample size:** Drinking water samples were collected from nine drinking water sites within the hospital. A total of 324 drinking water samples were collected during the study period.

**Sample collection and transport:** Water samples were collected in sterile screw-capped bottles using aseptic precautions. The samples were kept at 25°C and transported immediately to the microbiology laboratory for processing. (Figure 1)

**Bacteriological analysis:** The samples were tested for recent faecal contamination due to coliform bacteria.

Presumptive coliform count was performed by the multiple tube culture method using MacConkey purple broth. Single-strength and double-strength media were used. The inoculated tubes were incubated at 37°C for 48 hours. Tubes showing colour change were further processed for identification of organisms according to standard microbiological protocol. [5,6]

**Interpretation of water quality:** The most probable number table was used to assess the bacteriological quality of water. Samples were categorised as excellent, satisfactory, intermediate or unsatisfactory. (Table 1)

**Table 1: Classification of drinking water**

| Class | Presumptive coliform count/100 ml | E. coli count/100 ml |
|---|---|---|
| Class 1: Excellent | 0 | 0 |
| Class 2: Satisfactory | 1–3 | 0 |
| Class 3: Suspicious | 4–10 | 0 |
| Class 4: Unsatisfactory | >10 | 0.1 or more |

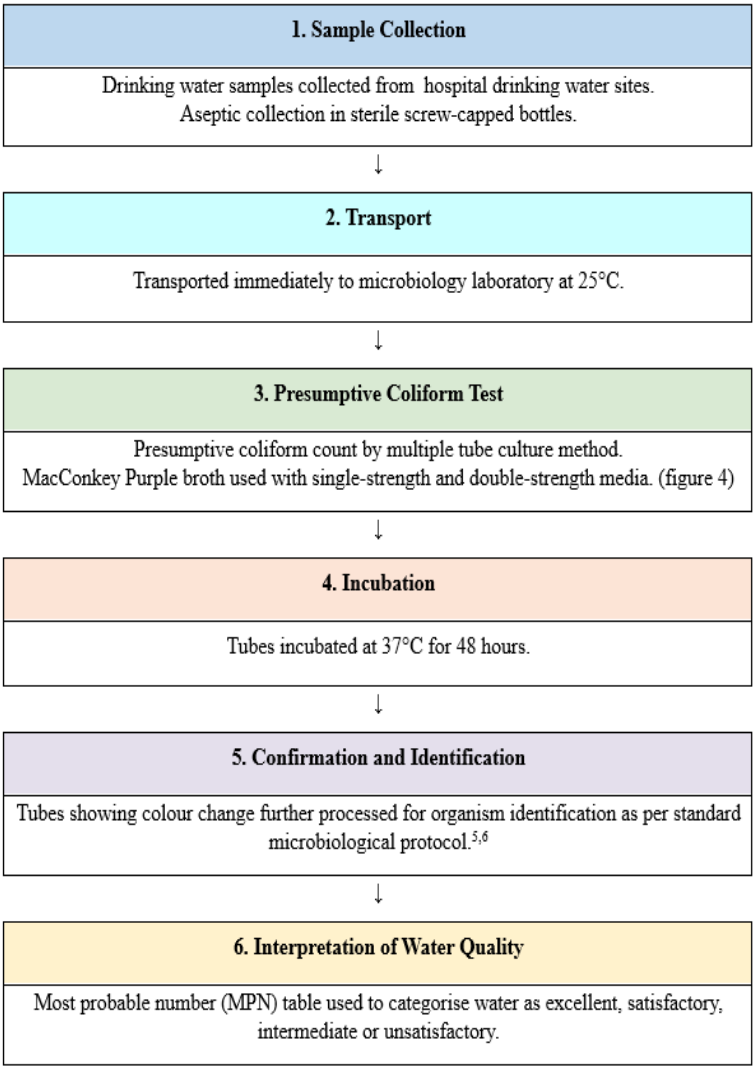


**Figure 1: Workflow for bacteriological processing of hospital drinking water.**

**Statistical Analysis:** Data were summarised using descriptive statistics. Categorical variables were expressed as frequency and percentage. Percentages were calculated using the total number of collected samples as the denominator.

**Ethical Considerations**: The study involved environmental drinking water samples only and did not involve human participants, patient samples, animal subjects or patient-identifiable information.

## Results

**Overall water quality**: A total of 324 drinking water samples were collected from nine hospital drinking water sites during the study period.

Out of these, 249 (76.9%) samples were categorised as excellent, 15 (4.6%) as satisfactory, 27 (8.3%) as intermediate and 33 (10.2%) as unsatisfactory. (Table 2, Figure 2)

**Table 2: Bacteriological quality categorisation of drinking water samples**

| Water quality category | Number of samples | Percentage |
|---|---|---|
| Excellent | 249 | 76.9% |
| Satisfactory | 15 | 4.6% |
| Intermediate | 27 | 8.3% |
| Unsatisfactory | 33 | 10.2% |
| **Total** | **324** | **100.0%** |

Percentages were calculated using the total number of drinking water samples, n = 324.

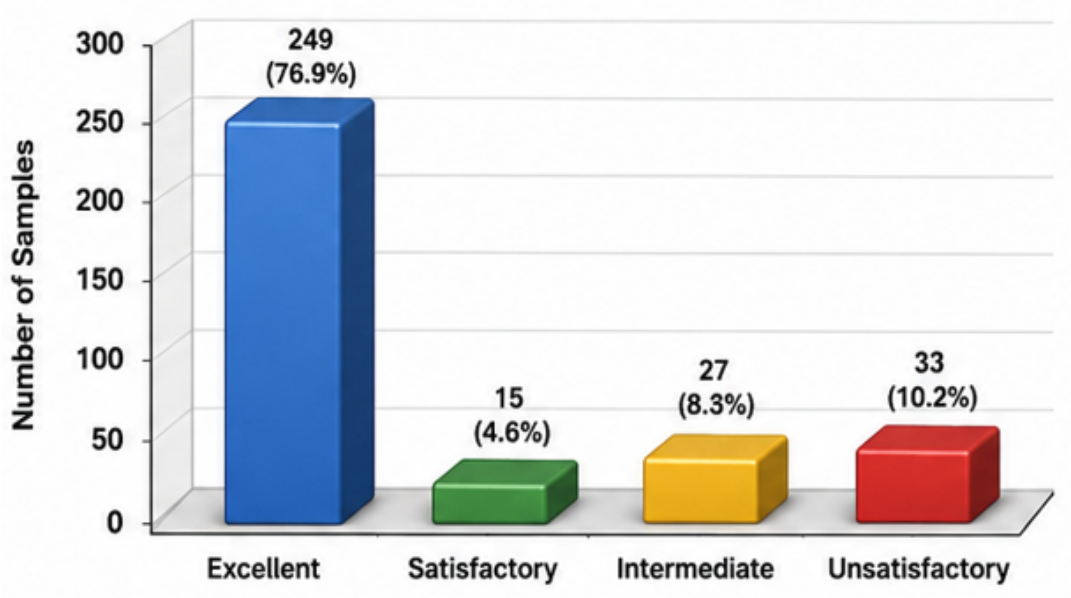


**Figure 2: Bacteriological quality categorisation of drinking water samples.**

**Distribution of bacterial isolates**: The most common organism isolated was Escherichia coli, which was detected in 48 (14.8%) samples. Pseudomonas species were isolated from 21 (6.5%) samples, and Klebsiella species were isolated from 6 (1.9%) samples. (Table 3, figure 3)

**Table 3: Bacterial isolates detected in drinking water samples**

| Organism isolated | Number of samples | Percentage |
|---|---|---|
| Escherichia coli | 48 | 14.8% |
| Pseudomonas species | 21 | 6.5% |
| Klebsiella species | 6 | 1.9% |
| No organism | 159 | 76.8% |

Percentages were calculated using the total number of drinking water samples, n = 324.

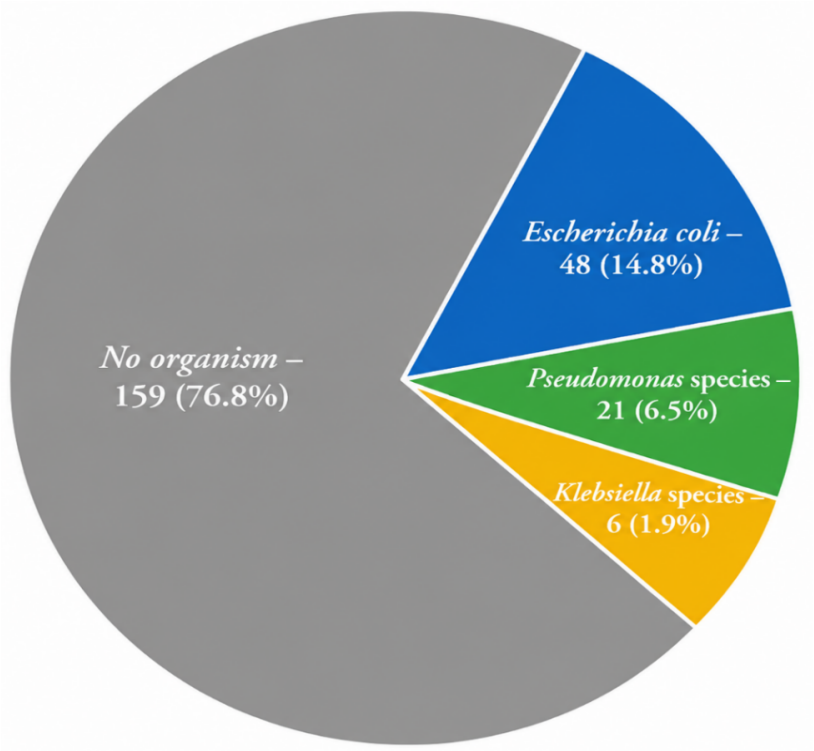


**Figure 3: Bacterial isolates detected in drinking water samples (n-324).**


**Figure 4: Presumptive coliform count performed using multiple tube method in the laboratory.**

**Most probable number:** The maximum reported most probable number value was 161.

**Discussion**

This hospital-based bacteriological survey assessed the drinking water quality of 324 samples collected from nine hospital drinking water sites over a one-year period. Most samples were classified as excellent; however, intermediate and unsatisfactory samples were also detected. Although most samples were bacteriologically acceptable, intermediate and unsatisfactory samples indicated contamination at some drinking water sites.

Drinking water safety standards emphasise that faecal indicator organisms should not be present in potable water. [1,2] CDC/HICPAC environmental infection-control guidelines also recognise water as an important environmental component in healthcare facilities. [3]

Anaissie et al. described hospital water supplies as a potential source of nosocomial infections and reported that microorganisms in hospital water systems may contribute to healthcare-associated infections. [4]

The detection of unsatisfactory samples in this study therefore supports periodic monitoring of hospital water sources rather than reliance on isolated testing. Previous Indian studies have also documented bacteriological contamination of drinking water using MPN or coliform-based methods in hospital and community settings. Kumar et al. evaluated drinking water by the MPN method in a tertiary care hospital and adjoining area in Western Uttar Pradesh, while Srivastava et al. assessed hospital and residential water supply in a tertiary care hospital of Northern India. [7,8]

A tertiary-care hospital-based study from Bangalore also reported the relevance of bacteriological testing of water samples from different hospital points. [9]

Studies from the catchment area of a tertiary-care teaching hospital, Amritsar district and Shimla hills have similarly supported routine bacteriological assessment of drinking water sources. [10-12]

Additional Indian studies from Jammu, Jabalpur and Chennai have used bacteriological or MPN-based methods to assess drinking water quality and have reported variable contamination across drinking water sources. [13-15]

The presence of unsatisfactory samples in a hospital environment is clinically relevant. Hospital water is used by patients, attendants, healthcare workers and staff, and repeated exposure to contaminated water may increase the risk of water-borne infections. In patient-care areas, even intermittent contamination may be significant, particularly for immunocompromised patients,

intensive-care patients, neonates and postoperative patients. Escherichia coli was the most frequently isolated organism. Its detection in drinking water is important because it is an indicator of recent faecal contamination. This may suggest contamination at the source, inadequate water treatment, improper storage, defective pipelines, contamination of outlets or failure of routine maintenance practices. The isolation of Pseudomonas species is also relevant in healthcare settings, as these organisms can survive in moist environments and may persist in biofilms within water-distribution systems. Klebsiella species may reflect environmental contamination of water sources.

Regular microbiological surveillance of hospital drinking water systems is required. Surveillance should not be limited to occasional testing but should be integrated into hospital infection-control activities. Corrective measures may include inspection and cleaning of storage tanks, maintenance of pipelines and outlets, evaluation of filtration systems, checking of residual disinfectant levels and repeat microbiological testing after remedial action.

Effective water safety surveillance requires coordination between the microbiology laboratory, infection-control team, engineering services, housekeeping department and hospital administration. Water safety in hospitals requires coordinated monitoring and timely response. Maintaining safe drinking water is particularly important in critical areas where patients are more vulnerable to infection.

**Limitations:** The available data did not include site-wise distribution of contamination, monthly or seasonal trends, residual chlorine levels, details of water treatment systems or repeat culture results after corrective measures. Including these parameters in future surveillance may help identify recurrent contamination sites.

## Conclusion

Most hospital drinking water samples were categorised as excellent; however, intermediate and unsatisfactory samples were also identified. Escherichia coli was the predominant organism isolated, followed by Pseudomonas species and Klebsiella species. Periodic bacteriological monitoring of hospital drinking water can help detect faecal contamination and support timely corrective action.

## Declarations

**Acknowledgments:** The authors acknowledge the support of the Department of Microbiology, Hind Institute of Medical Sciences, Barabanki, Uttar Pradesh, India, for providing laboratory facilities required for the bacteriological analysis of drinking water samples.

**Author Contributions:** Dr Pratibha Pandey contributed to sample collection, laboratory processing, data compilation, literature review and preparation of the manuscript.

Dr Anjali Agarwal contributed to study conception, supervision, and microbiological interpretation, and academic guidance, critical revision of the manuscript and final approval of the manuscript.

Both authors read and approved the final manuscript.

**Ethics approval and consent to participate:** Not applicable, as the study involved environmental drinking water samples only and did not involve human participants, human biological material, animal subjects or patient-identifiable information.

**Availability of data and materials:** The data supporting the findings of this study are available from the corresponding author upon reasonable request.

**Guarantor**: Dr Pratibha Pandey will act as the guarantor for the study and accepts responsibility for the integrity of the work as a whole.

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