

CATHETER-ASSOCIATED URINARY TRACT INFECTIONS IN INTENSIVE CARE UNITS: EPIDEMIOLOGY, RISK FACTORS, PREVENTION STRATEGIES, AND FUTURE PERSPECTIVES

Ritika Rani^{*1}, Dr. Praveen Kumar², Agam Verma³, Ayash Ashraf³

¹M.Sc. (MLT), Faculty of Allied and Healthcare, Guru Kashi University.

²Assistant Professor, Faculty of Allied and Healthcare, Guru Kashi University.

³Assistant Professor, Faculty of Allied and Healthcare, Guru Kashi University.

Article Received: 20 June 2026, Article Revised: 10 July 2026, Published on: 30 July 2026

*Corresponding Author: Ritika Rani

M.Sc. (MLT), Faculty of Allied and Healthcare, Guru Kashi University.

Doi: <https://doi-org/101555/ijarp.3250>

ABSTRACT

Catheter-associated urinary tract infections (CAUTIs) remain one of the most prevalent healthcare-associated infections (HAIs), particularly among critically ill patients admitted to intensive care units (ICUs). The widespread use of indwelling urinary catheters, prolonged hospitalization, invasive procedures, and compromised immunity significantly increase the susceptibility of ICU patients to CAUTIs. The COVID-19 pandemic further intensified the burden of these infections due to increased catheter utilization, prolonged ICU stays, and disruption of infection prevention practices. This review summarizes the current evidence regarding the epidemiology, microbial etiology, risk factors, diagnosis, prevention, and management of CAUTIs in ICU settings. It also discusses the impact of the COVID-19 pandemic on infection trends and highlights evidence-based interventions including catheter care bundles, antimicrobial stewardship, nurse-led catheter removal protocols, and surveillance systems. Strengthening infection prevention strategies and implementing multidisciplinary approaches are essential for reducing CAUTI incidence and improving patient outcomes.

KEYWORDS: Catheter-associated urinary tract infection, ICU, healthcare-associated infection, COVID-19, infection prevention, urinary catheter

1. INTRODUCTION

Healthcare-associated infections continue to represent a major challenge for healthcare systems worldwide. Among these infections, catheter-associated urinary tract infections (CAUTIs) account for approximately 70–80% of all healthcare-associated urinary tract infections and are particularly common in intensive care units (ICUs). The widespread use of indwelling urinary catheters for critically ill patients has significantly contributed to increased infection rates.

The risk of developing CAUTI increases with prolonged catheterization, inadequate catheter care, advanced age, diabetes, immunosuppression, and prolonged hospitalization. During the COVID-19 pandemic, healthcare facilities experienced increased ICU admissions and prolonged catheter use, leading to a notable rise in healthcare-associated infections. Consequently, preventing CAUTIs has become an important priority in infection control programs.

2. Epidemiology of CAUTI

CAUTIs account for nearly one-third of all hospital-acquired infections worldwide. Studies indicate that approximately 15–25% of hospitalized patients require urinary catheterization during their hospital stay, while catheter utilization exceeds 80% among ICU patients.

Every additional day of catheterization increases the risk of bacteriuria by approximately 3–7%. If catheterization continues beyond one week, bacterial colonization becomes highly likely, eventually progressing to symptomatic urinary tract infection in susceptible patients.

Several surveillance studies conducted before and after the COVID-19 pandemic demonstrated increased CAUTI incidence due to:

- Increased ICU admissions
- Longer duration of catheterization
- Staff shortages
- Increased workload
- Reduced compliance with infection prevention practices

3. Risk Factors Associated with CAUTI

Multiple patient-related and healthcare-related factors contribute to CAUTI development.

Patient-related factors

- Advanced age
- Female gender
- Diabetes mellitus

- Chronic kidney disease
- Immunocompromised status
- Prolonged ICU stay
- COVID-19 infection
- Previous urinary tract infections

Device-related factors

- Long duration of catheterization
- Improper catheter insertion
- Breaks in aseptic technique
- Closed drainage system failure
- Biofilm formation
- Catheter obstruction

Healthcare-related factors

- Poor hand hygiene
- Inadequate staff training
- Lack of catheter care protocols
- Delayed catheter removal
- High patient-to-nurse ratio
- Limited infection surveillance

The duration of catheterization remains the single most important predictor of CAUTI development.

4. Microbiology of CAUTI

CAUTIs are polymicrobial infections caused by both Gram-negative and Gram-positive bacteria.

The most frequently isolated organisms include:

- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Pseudomonas aeruginosa*
- *Proteus mirabilis*
- *Enterococcus faecalis*
- *Candida* species

Biofilm formation on catheter surfaces protects microorganisms from antibiotics and host

immune responses, making infections persistent and difficult to eradicate. Multidrug-resistant organisms (MDROs) have become increasingly common in ICU settings, particularly after the COVID-19 pandemic.

5. Impact of COVID-19 on CAUTI

The COVID-19 pandemic dramatically altered infection control practices worldwide. Several studies reported increased healthcare-associated infections because of:

- Increased mechanical ventilation
- Longer ICU stays
- Increased urinary catheter utilization
- Reduced nurse-to-patient ratio
- Overburdened healthcare systems
- Frequent use of broad-spectrum antibiotics

Patients with severe COVID-19 often required prolonged urinary catheterization because of immobilization and intensive monitoring, increasing their risk of CAUTIs. Although strict personal protective equipment (PPE) protocols improved hand hygiene in many hospitals, competing clinical priorities sometimes delayed catheter removal and routine catheter care.

6. Diagnosis of CAUTI

Diagnosis requires both clinical assessment and microbiological confirmation. Common clinical manifestations include:

- Fever
 - Suprapubic tenderness
 - Flank pain
 - Dysuria
 - Costovertebral angle tenderness
 - Altered mental status in elderly patients
- Laboratory investigations include:
- Urine microscopy
 - Urine culture
 - Urinalysis
 - Blood cultures (when sepsis is suspected)

Diagnosis should follow standardized guidelines to distinguish true infection from asymptomatic bacteriuria, thereby avoiding unnecessary antibiotic use.

7. Prevention Strategies

Prevention remains the most effective approach for reducing CAUTIs.

Appropriate catheter use

Catheters should only be inserted when medically indicated.

Aseptic insertion

Strict sterile technique during catheter insertion significantly reduces infection risk.

Hand hygiene

Proper hand hygiene before and after catheter manipulation remains the cornerstone of infection prevention.

Catheter maintenance

- Maintain a closed drainage system.
- Ensure unobstructed urine flow.
- Avoid unnecessary disconnections.
- Keep the collection bag below bladder level.

Early catheter removal

Daily assessment of catheter necessity and nurse-driven removal protocols significantly reduce catheter days.

Education and training

Continuous education of healthcare workers improves compliance with infection prevention guidelines.

Surveillance

Regular monitoring of CAUTI rates helps identify outbreaks and evaluate infection prevention programs.

8. Role of Nurses in Preventing CAUTI

Nurses play a central role throughout catheter management.

Their responsibilities include:

- Assessing catheter necessity
- Maintaining aseptic technique
- Performing routine catheter care
- Monitoring for infection
- Educating patients
- Prompt catheter removal

- Documentation of catheter days

Studies consistently demonstrate that nurse-led catheter removal protocols reduce CAUTI incidence and healthcare costs.

9. Future Perspectives

Emerging technologies are expected to improve CAUTI prevention. These include:

- Antimicrobial-coated urinary catheters
- Silver-alloy coated catheters
- Biofilm-resistant biomaterials
- Electronic catheter reminder systems
- Artificial intelligence-based infection surveillance
- Automated clinical decision support systems

Future multicenter prospective studies are required to evaluate these innovations and improve infection prevention policies.

10. CONCLUSION

Catheter-associated urinary tract infections continue to impose a considerable burden on ICU patients, healthcare professionals, and healthcare systems. Prolonged catheterization, invasive procedures, multidrug-resistant organisms, and compromised immunity remain major contributors to infection. The COVID-19 pandemic further highlighted weaknesses in infection prevention programs, emphasizing the need for robust surveillance, evidence-based catheter care bundles, antimicrobial stewardship, and multidisciplinary collaboration. Implementation of standardized prevention protocols, continuous healthcare worker education, and timely catheter removal remain the most effective strategies for minimizing CAUTI incidence and improving patient safety.

REFERENCES

1. Agado, B. J. (2020). Prevention of catheter-associated urinary tract infections in hospitalized patients. *Journal of Infection Prevention*, 21(6), 214–221.
2. Andersen, M. J., & Flores-Mireles, A. L. (2019). Urinary catheter-associated biofilms. *Current Bladder Dysfunction Reports*, 14(1), 18–25.
3. Baker, M. A., Sands, K. E., Huang, S. S., et al. (2021). The impact of COVID-19 on healthcare-associated infections. *Infection Control & Hospital Epidemiology*, 43(12),

1651–1658.

5. Centers for Disease Control and Prevention. (2019). *Guideline for prevention of catheter-associated urinary tract infections*.
6. Fakih, M. G., Bufalino, A., Sturm, L., et al. (2021). Coronavirus disease 2019 pandemic, healthcare-associated infections, and antimicrobial stewardship. *Infection Control & Hospital Epidemiology*, 43(1), 26–32.
7. Haque, M., Sartelli, M., McKimm, J., & Abu Bakar, M. (2018). Health care-associated infections—An overview. *Infection and Drug Resistance*, 11, 2321–2333.
8. Kranz, J., Schmidt, S., Wagenlehner, F., et al. (2020). Catheter-associated urinary tract infections. *Deutsches Ärzteblatt International*, 117(6), 83–88.
9. Knepper, B. C., McLeod, G., Miller, A., et al. (2020). Device-associated infection rates during the COVID-19 pandemic. *Infection Control & Hospital Epidemiology*, 43(12), 1742–1744.
10. Letica-Kriegel, A. S., Salmasian, H., Vawdrey, D. K., et al. (2019). Identifying risk factors for catheter-associated urinary tract infections. *Clinical Infectious Diseases*, 68(6), 980–986.
11. Meddings, J., Saint, S., Fowler, K. E., et al. (2019). The Ann Arbor criteria for appropriate urinary catheter use. *Annals of Internal Medicine*, 171(9), S1–S34.
12. Mong, K., Greene, M. T., & Saint, S. (2022). Preventing catheter-associated urinary tract infections through nursing interventions. *American Journal of Infection Control*, 50(5), 523–530.
13. Weiner-Lastinger, L. M., Pattabiraman, V., Konnor, R. Y., et al. (2022). Changes in healthcare-associated infection epidemiology during the COVID-19 pandemic. *American Journal of Infection Control*, 50(5), 531–538.
14. World Health Organization. (2022). *Global report on infection prevention and control*.